MODEL SR560

LOW-NOISE PREAMPLIFIER

STANFORD RESEARCH SYSTEMS

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INTRODUCTION AND SETUP

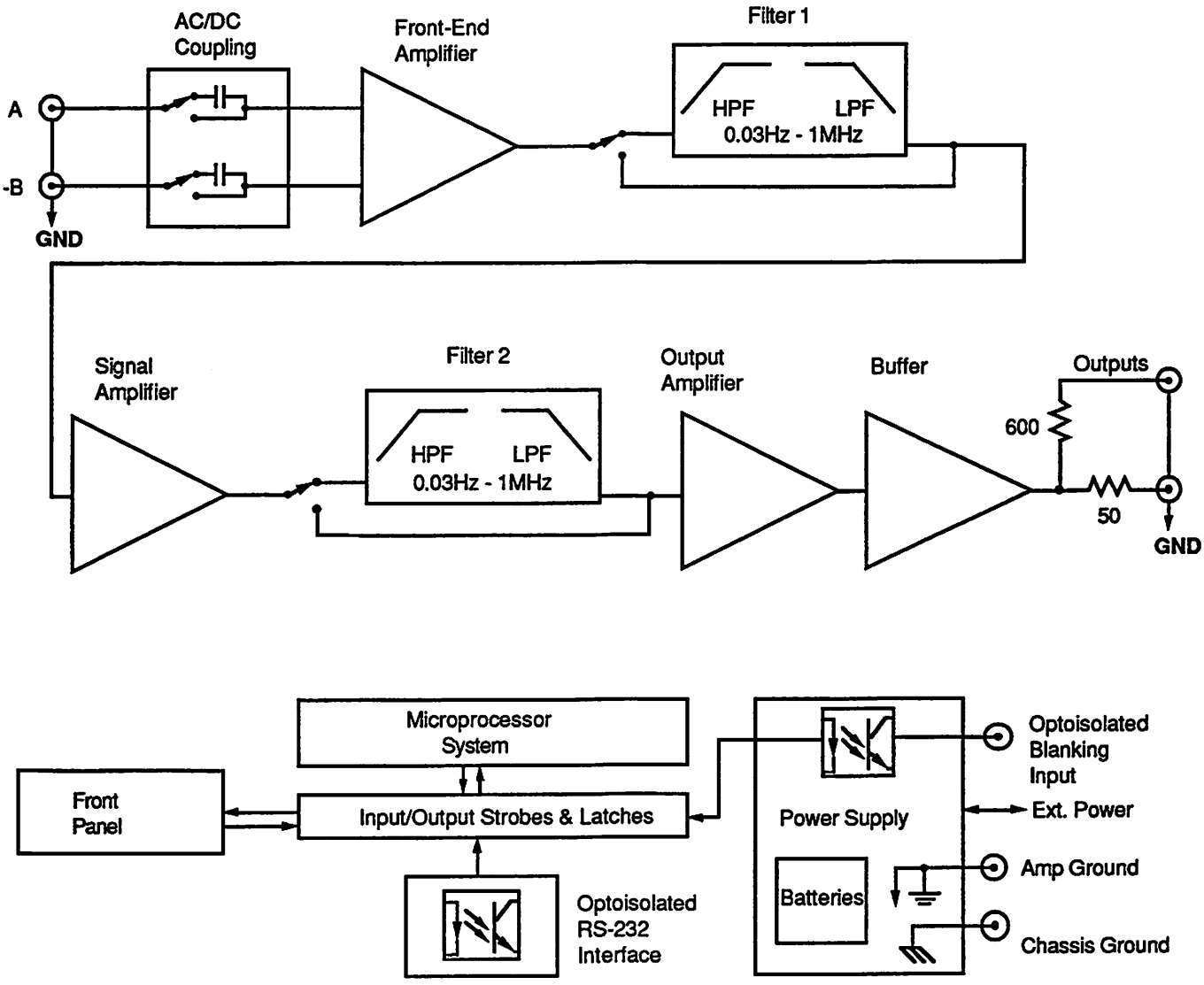


Figure 1: SR560 Block Diagram

INSTRUMENT OVERVIEW

The SR560 architecture is diagrammed above. The instrument provides DC-coupled low-noise amplification of single-ended and true differential input signals at gains of 1 to 50,000. Two configurable R-C filters are provided to selectively condition signals in the frequency range from DC to 1 MHz. The user can choose high dynamic reserve or low noise settings, and can invert the output relative to the input. The SR560 normally operates with a fully-floating ground and can be viewed as an "in-line-BNC amplifier" with the amplifier ground isolated from the chassis and the AC power supply. Opto-isolated input blanking control and listen-only RS-232 interface lines are provided for instrument control. Digital noise is eliminated by shutting down the microprocessor's oscillator except during the short time required to alter the instrument's configuration, either through a front-panel pushbutton or through an RS-232 command. Internal sealed lead-acid batteries pro-

vide 20 hours of line-independent operation. Rear panel banana jacks provide access to the internal regulated power supplies (or batteries) for use as a bias source.

PREPARATION FOR USE

************CAUTION************

This instrument may be damaged if operated with the LINE VOLTAGE SELECTOR card set for the wrong applied AC input source voltage or if the wrong fuse is installed.

Line Voltage

When the AC power cord is connected to the unit and plugged into an AC outlet, the unit automatically switches the amplifier power source from internal battery operation to line operation. The internal batteries are charged as long as AC power is connected.

The SR560 can operate from a 100 V, 120 V, 220 V or 240 V nominal AC power source having a line frequency of 50 or 60 Hz. Before connecting the power cord to a power source, verify that the LINE VOLTAGE SELECTOR card, located in the rear-panel fuse holder of the unit, is set so that the correct AC input voltage value is visible.

Conversion from one AC input voltage to another requires a change in the fuse holder's LINE VOLTAGE SELECTOR card position and a new fuse. Disconnect the power cord, slide the fuse holder cover to the left and rotate the fuse-pull lever to remove the fuse. Remove the small printed circuit board. Select the operating voltage by orienting the printed circuit board. Press the circuit board firmly into its slot, so the desired voltage is visible. Rotate the fuse-pull lever back into its normal position and insert the correct fuse into the fuse holder.

Line Fuse

Verify that the correct line fuse is installed before connecting the line cord to the unit. For 100 V and 120 V, use a 1 Amp fuse and for 220 V and 240 V, use a 1/2 Amp fuse.

Line Cord

The SR560 has a detachable, three-wire power cord with a three-contact plug for connection to both the power source and protective ground. The protective ground connects to the accessible metal parts of the instrument except for BNC shields. To prevent electrical shock, always use a power source outlet that has a properly grounded protective-ground contact.

Ventilation

Always ensure adequate ventilation when operating the SR560 . The unit will generate heat while charging dead batteries.

Power-Up

All instrument settings are stored in nonvolatile memory (RAM backed-up) and are retained when the power is turned off. They are not affected by the removal of the line cord. If the power-on self test passes, the unit will return to the settings in effect when the power was last turned off. If an error is detected or if the backup battery is exhausted, the default settings will be used. Additionally, if the RESET key is held down when the power is turned on, the instrument settings will be set to the defaults shown below:

Parameter	Setting
SOURCE	Channel A
COUPLING	DC
INVERT	OFF
ROLLOFF	bypassed
HIGH-PASS	0.03 Hz, +6 dB/oct
LOW-PASS	1 MHz, -6 dB/oct
GAIN MODE	High Dynamic Reserve
GAIN	20, calibrated
LISTEN	ON
DEVICE ADDRESS	As per SW601

Repackaging for Shipment

The original packing materials should be saved for reshipment of the SR560. If the original packing materials are not available, wrap the instrument in polyethylene sheeting or equivalent and place in a strong box, cushioning it on all sides by at least three inches of high-density foam or other filler material.

Use in Biomedical Applications

Under certain conditions, the SR560 may prove to be unsafe for applications involving human subjects. Incorrect grounding, component failure, and excessive common-mode input voltages are examples of conditions in which the instrument may expose the subject to large input currents. Therefore, Stanford Research Systems does not recommend the SR560 for such applications.

Warning Regarding Use with Photomultipliers

The front end amplifier of this instrument is easily damaged if a photomultiplier is used improperly with the amplifier. When left completely unterminated, a cable connected to a PMT can charge to several hundred volts in a relatively short time. If this cable is connected to the inputs of the SR560, the stored charge may damage the front-end FETs. To avoid this problem, provide a leakage path of about 100 k to ground inside the base of the PMT to prevent charge accumulation.

Accessories Furnished

- Power cable
- Operating Manual

Environmental Conditions

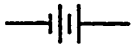
OPERATING
Temperature: 10° C to 40° C
Relative Humidity: < 90% Non-condensing

NON-OPERATING
Temperature: -25° C to +65° C
Relative Humidity: < 95% Non-condensing

Warning regarding battery maintenance

Batteries used in this instrument are seal lead acid batteries. With usage and time these batteries can leak. Always use and store this instrument in the feet-down position. To prevent possible damage to the circuitboard, it is recommended that the batteries be periodically inspected for any signs of leakage.

Symbols you may find on SRS products.

Symbol	Description
	Alternating current
	Caution - risk of electric shock
	Frame or chassis terminal
	Caution - refer to accompanying documents
	Earth (ground) terminal
	Battery
	Fuse
	On (supply)
	Off (supply)

SPECIFICATIONS

SR560 LOW-NOISE PREAMPLIFIER SPECIFICATIONS CHART

Inputs	Single-ended or true differential.
Impedance	100 MOhm + 25 pF, DC-coupled.
Maximum Inputs	1 VDC before overload; 3 V peak to peak max AC coupled; protected to 100 VDC.
Maximum Output	10 V peak to peak
Noise	< 4 nV / √Hz at 1 kHz.
CMRR	> 90 dB to 1 kHz, decreasing by 6 dB / octave (20 dB / decade) above 1 kHz.
Gain Accuracy	1%, DC to 10 kHz 3%, 10 kHz to 100 kHz.
Gain Stability	200 ppm / °C.
DC Drift	5μV/ °C reffered to input (DC coupled)
Filters	0.03 Hz to 1 MHz, 10% typical accuracy.
Distortion	0.01% typical.
Power	100, 120, 220, 240 Vac (50/60 Hz) 60 Watts Max. Internal Batteries: 3 x 12 V, 1.9 Ah sealed lead-acid (rechargeable). ±12 VDC in / out through rear panel banana jacks.
Battery Life	20 hours nominal 250-1000 charge / discharge cycles.
Charge Time	4 hours to 80% of capacity.
Mechanical	1/2 Rack-Mount width, 3 1/2" height weight 15 lbs.
Dimensions	14-7/8" x 8-1/8" x 3-1/2".
Warranty	1 year parts and labor on materials and workmanship.

OPERATION AND CONTROLS

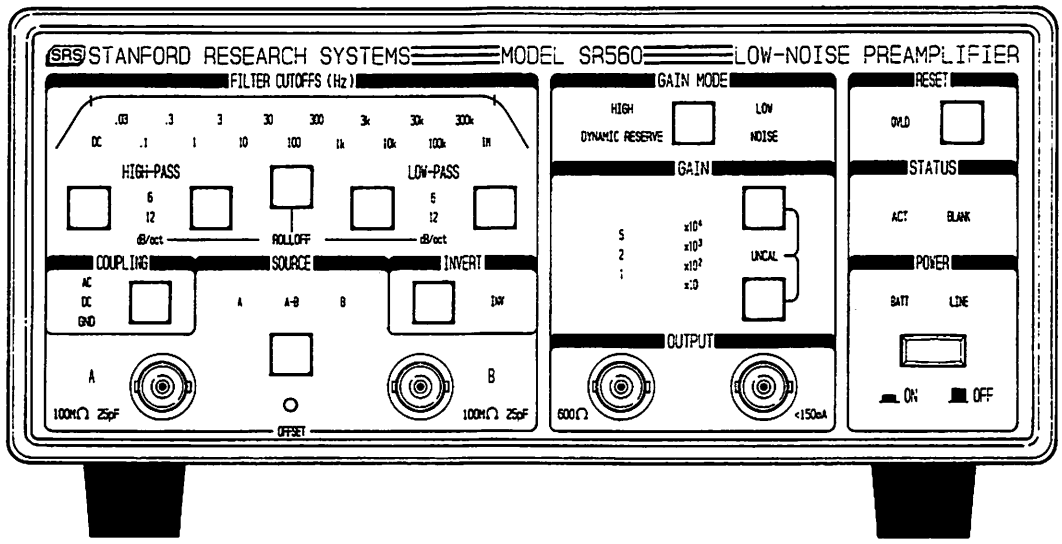


Figure 2: SR560 Front Panel

FRONT PANEL OPERATING SUMMARY

The operation of the SR560 Low-Noise Preamplifier has been designed to be as simple as possible. The effect of each keypress on the front panel is reflected in the change of a nearby LED. The front panel LEDs will remain lighted at all times unless dip switch SW601 (accessible through the bottom cover of the unit) positions 3 and 4 are placed in the "off" position. All front panel functions can be controlled through the rear-panel RS-232 interface.

Power

The SR560 is turned on by depressing the **POWER** switch. When disconnected from AC power, the unit will operate for approximately 20 hours on internal sealed lead-acid batteries. Up to 200 mA of unregulated battery power is available at the rear panel banana jacks as long as the power switch is in the ON position. Battery life will be reduced when the unit is providing external power through the rear panel jacks. When operating on batteries, the front panel "BATT" indicator will be lighted. As the batteries near exhaustion, this indicator will change from green to red, indicating that the unit should be connected to AC power to charge the batteries.

When connected to an AC power source, amplifier power is derived from regulated line power, and the internal batteries are automatically charged. When operating on AC power, the front panel "LINE" indicator is on to indicate the source of amplifier power. Charging status is indicated on the rear panel by the "CHARGE" and "MAINTAIN" LED indicators.

Source

There are two input connectors located in the **SOURCE** section of the front panel. The push-button located between them selects single-ended (**A**), differential (**A-B**), or single-ended(**B**) inputs.

The **A** and **B** inputs are voltage inputs with 100

MOhm, 25 pF input impedance. Their connector shields are completely isolated from chassis ground, but can be made common with chassis ground by connecting the "AMP GROUND" and "CHASSIS GROUND" banana jacks on the rear panel of the SR560. When connected to AC power, the chassis of the unit is always connected to the grounding conductor of the AC power cord. The inputs are protected to 100 VDC but the DC input should never exceed 10 V peak. The maximum DC input before overload is 1 V peak.

The **COUPLING** pushbutton selects the method of connecting the **A** and **B** inputs to the amplifier. The inputs can be AC (0.03 Hz - 3 dB) or DC-coupled, or the inputs to the amplifier can be internally grounded with the **A** and **B** input BNCs left floating. This feature makes for simple offset nulling, particularly useful when operating the amplifier DC-coupled at high gains. Please refer to CALIBRATION AND REPAIR – OFFSET ADJUSTMENT for information on the offset nulling procedure.

NOTE: When the coupling is set to AC, a 0.03 Hz cutoff high-pass filter is always engaged. All high-pass filter modes can still be selected while AC-coupled, but the 0.03 Hz filter will always be in, even if the filters are set to DC. Because one of the two filter sections is always used as a high pass when AC coupling is selected, low-pass filters are only available with a 6 dB / octave rolloff.

The **INVERT** pushbutton allows the user to invert the output of the instrument with respect to the input when operating with single-ended or differential inputs. The **INVERT** LED displays the output sense relative to the input for all **SOURCE** settings.

Filters

The SR560 contains two identical 1st-order R-C filters whose cutoff frequencies and topology (high-pass or low-pass) are controlled from the front panel. The maximum bandwidth of the instrument is 1 MHz. The filters in the **FILTER CUTOFFS** section can be configured in the following six ways:

i. high-pass filter at +12 dB / octave
ii. high-pass filter at +6 dB / octave
iii. high-pass filter at +6 dB / octave, and low-pass filter at -6 dB / octave (band-pass)
iv. low-pass filter at -6 dB / octave
v. low-pass filter at -12 dB / octave
vi. no filters in the signal path

The filter settings are controlled by the ROLLOFF, HIGH-PASS and LOW-PASS pushbuttons. Each time the ROLLOFF pushbutton is pressed the instrument configures the two R-C filters to conform to the progression shown above. The four ROLLOFF LEDs give a visual indication of the current filter configuration. For the HIGH-PASS filter the left pushbutton serves to decrease its cutoff frequency. The two pushbuttons for the LOW-PASS filter function in an analagous manner.

When the **FILTER CUTOFFS** section is configured solely as high-pass or low-pass (i, ii, iv and v), the cutoff frequency is illuminated by one of sixteen LEDs in the range from 0.03 Hz to 1 MHz, and the slope of the rolloff is shown by one of the four ROLLOFF LEDs . When the filter section is configured as band-pass (iii), the cutoff frequencies are illuminated by two LEDs. The frequency setting on the left marks the cutoff for the high-pass filter, and the setting on the right is the cutoff for the low-pass filter. The two 6 dB / oct ROLLOFF LEDs are also illuminated. In this case the two cutoffs can be set to the same frequency to provide a narrow bandpass. When both filters are removed from the signal path (vi) all rolloff and cutoff frequency LEDs are extinguished from the FILTER CUTOFFS section and the DC LED is on.

NOTE: High pass filters are not available for the four highest frequency settings. See the note under **Source: Coupling** for information on using filters with the amplifier in AC coupled mode.

Gain Mode

The allocation of gain throughout the instrument is set using the **GAIN MODE** pushbutton The Gain Mode is displayed by two indicator LEDs: HIGH DYNAMIC RESERVE and LOW NOISE. For a given gain setting, a HIGH DYNAMIC RESERVE allocates the SR560's gain toward the output stages after the filters. This prevents signals which are attenuated by the filters from overloading the amplifier. The LOW NOISE setting allocates gain toward the front-end in order to quickly "lift" low-level (nV range) signals above the instrument's noise floor.

Gain

The instrument's gain is increased or decreased using the **GAIN** pushbuttons. Gain settings from 1 to 50,000 are available and are displayed as the product of a factor 1, 2 or 5 and a multiplier (none (i.e. 1), 10, 100, 1,000 or 10,000). In addition to these fifteen fixed gain settings, the user may specify arbitrary gains through the UNCAL feature. To set an uncalibrated or arbitrary gain the user must press both Gain buttons simultaneously, lighting the UNCAL LED. In this mode by pressing the Gain Up or Gain Down pushbuttons, the user may reduce the calibrated gain in roughly 1% increments from 100% down to 0% of the selected gain. In contrast to other front-panel functions, when in UNCAL the instrument's key-repeat rate will start slowly and increase to a limit as long as either Gain button is depressed. Simultaneously pressing both Gain buttons once again will restore the unit to the previously calibrated gain setting, and turn off the UNCAL LED.

Output

The outputs of the instrument are located within the **OUTPUT** section of the front panel. Two insulated BNCs are provided: a 600 ohm output and a 50 ohm output. The amplifier normally drives high impedance loads and the instrument's gain is calibrated for high impedance loads. When driving a 600 ohm load via the 600 ohm output (or a 50 ohm load via the 50 ohm output) the gain of the amplifier is reduced by two. The shields of all the front-panel BNCs are connected together and form the amplifier's floating ground.

Reset

The OVLD LED indicates a signal overload. This condition can occur when a signal is too large or the dynamic reserve is too low. Reducing the gain, reducing the input signal and/or switching to the HIGH DYNAMIC RESERVE setting should remedy this condition. If an overload occurs with filter settings of long time constants, the **RESET** pushbutton will speed the SR560's recovery from overload.

Status

The ACT LED indicates communications activity over the SR560's optoisolated RS-232 port. Please refer to **Appendix A: Remote Programming** for further details on programming the instrument via RS-232.

The BLANK LED indicates the optoisolated **BLANKING** input (on the rear panel of the SR560) is active. The SR560 responds to a blanking input by internally grounding the amplifier signal path after the front end and before the first filter stage.

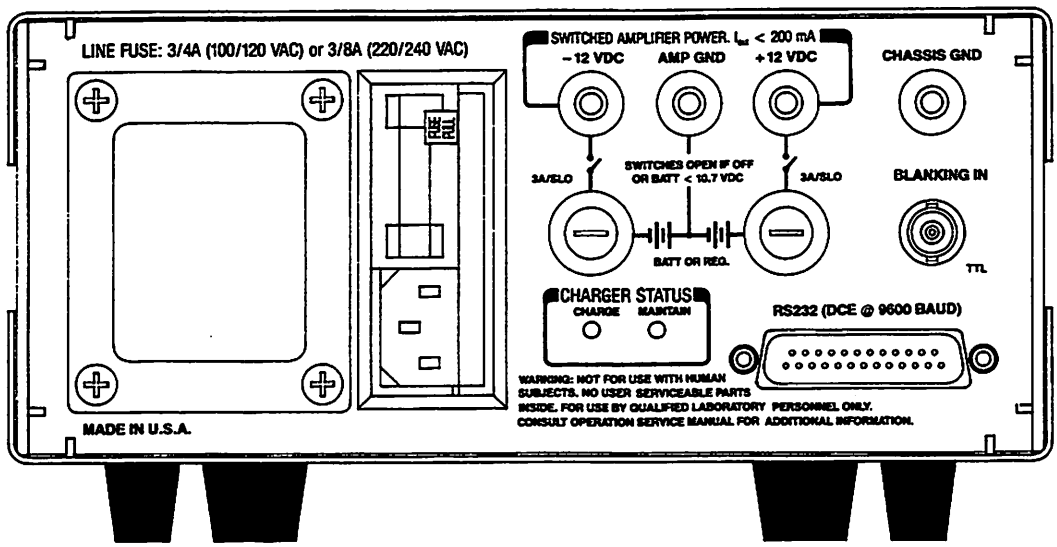

LINE FUSE: 3/4A (100/120 VAC) or 3/8A (220/240 VAC)
SWITCHED AMPLIFIER POWER. I < 200 mA
-12 VDC
AMP GND
+12 VDC
CHASSIS GND
3A/SLO
SWITCHES OPEN IF OFF OR BATT < 10.7 VDC
3A/SLO
BLANKING IN
BATT OR REG.
TTL
CHARGER STATUS
CHARGE
MAINTAIN
RS232 (DCE @ 9600 BAUD)
WARNING: NOT FOR USE WITH HUMAN SUBJECTS. NO USER SERVICEABLE PARTS INSIDE. FOR USE BY QUALIFIED LABORATORY PERSONNEL ONLY. CONSULT OPERATION SERVICE MANUAL FOR ADDITIONAL INFORMATION.
MADE IN U.S.A.

Figure 3: SR560 Rear Panel

REAR PANEL OPERATING SUMMARY

The SR560 rear panel is pictured in Figure 3. Various interface and power connectors are provided, along with fuses and charger status LEDs.

AC Power Input

The power entry module contains the receptacle for the AC line cord and fuse. The line fuse should be a 1 A slow-blow for 100/120 VAC operation, or a 1/2 A slow-blow for 220/240 VAC operation.

Amplifier Power Output

The -12 V, +12 V, and AMP GROUND banana jacks provide external DC power up to 200 mA for use as a bias source referenced to the amplifier's floating power supplies.

The CHASSIS GROUND banana jack is provided to allow the amplifier's ground to be referenced to the chassis. If the unit is connected to an AC power source via a three prong grounding plug, the chassis ground is connected to the AC line ground conductor.

Battery Charger

The two 3 A slow-blow fuses protect the battery supply and charging circuitry. If these fuses are blown, battery power will be unavailable, and charging of the batteries will not be possible.

When both the positive and negative supply batteries are dead, the red "CHARGE" LED will be on brightly, and the batteries will be charging at a fast rate. When the batteries approach a fully charged condition, the charging current will be reduced to complete the charge and maintain the batteries. Because the batteries charge at different rates, the indicators on the rear panel can reflect the charge status of the positive and negative batteries independently. When one set of batteries switches to the "MAINTAIN" mode, the red "CHARGE" LED will be reduced to half brightness, and the yellow "MAINTAIN" LED will turn on at half brightness. When both batteries switch to "MAINTAIN", the red "CHARGE" LED will turn off and the yellow "MAINTAIN" LED will be on full brightness.

Blanking Input

The blanking input accepts a TTL-level signal and grounds the amplifier signal path after the front end for as long as the input is held high. The response time of the blanking input is typically "on" 5 µs after the rising edge and "off" 10 µs after the falling edge.

RS-232 Interface

The RS-232 interface connector allows listen-only communication with the SR560 at 9600 baud, DCE. Communication parameters should be set to 8 bits, no parity, 2 stop bits. Data sent must be delimited by <CR> <LF>. All front panel functions excluding power and blanking, are available over the RS-232 interface. For more information on programming and commands, see **Appendix A: Remote Programming**.

BATTERY CARE AND USAGE

The SR560 can be powered from either an AC power source or from three 12 V, 1.9 Amp-hour maintenance-free sealed lead-acid rechargeable batteries. Integral to the SR560 is an automatic battery charger, along with battery protection and charge indication circuitry.

Recharging

During battery operation, the front panel BATT LED will change from green to red to indicate that the batteries are low and require charging. For the longest battery life, the batteries should be immediately charged by plugging the unit into AC power whenever the BATT indicator lights red. Internal protection circuitry will disconnect the batteries from the amplifier if the unit is operated for too long in the low battery condition. This protects the batteries from permanent damage which could occur if they were to remain connected to a load while dead.

The internal battery charging circuitry of the SR560 will automatically charge dead batteries at a quick rate until they are approximately 80% charged. The charge rate is then lowered to a level that is safe for maintaining the batteries. During AC operation, the batteries will be in this "maintain" charge condition indefinitely, and will suffer no degredation from prolonged charging. The sealed lead-acid batteries used in the SR560 differ in this respect from nickel-cadmium batteries, which do suffer shortened lifetimes due to overcharging. The sealed lead-acid batteries will provide the longest service life if they are not allowed to discharge too deeply and if they are charged immediately after use.

Battery Care

WARNING: As with all rechargeable batteries, for safety reasons the chemical recombination processes within the cells require that the batteries be allowed to vent non-corrosive gases to the atmosphere. Always use the batteries in an area with adequate ventilation.

As with all instruments powered by rechargeable batteries, the user must take some precautions to ensure long battery life. Understanding and following the precautions outlined below will result in a long operating life for the batteries in the SR560.

The SR560's internal lead-acid batteries will have a variable service life directly affected by THE NUMBER OF DISCHARGE CYCLES, DEPTH OF DISCHARGE AND AMBIENT TEMPERATURE. The user should follow these simple guidelines below to ensure longest battery life.

- AVOID DEEP DISCHARGE

  Recharge the batteries after each use. The two-step fast-charge / trickle-charge operation of the SR560 allows the charger to be left on indefinitely. ALWAYS recharge the batteries immediately after the BATT indicator LED on the SR560 turns red. Built-in protection circuitry in the unit removes the batteries from the load once a dead-battery condition is detected. Avoiding deep discharge will provide the longest battery life - upwards of 1,000 charge / discharge cycles.

- AVOID TEMPERATURE EXTREMES

  When using battery power, operate the SR560 at or near room temperature. Operating at lower temperatures will reduce the capacity of the batteries. As well, more time will be required to recharge the batteries to their rated capacity. Higher temperatures accelerate the rate of reactions within the cell, reduc-

ing cell life.

- KEEP THE BATTERIES COOL

When not in use, the SR560 should be stored in a cool, dry place with the batteries fully charged. This reduces the self-discharge of the batteries and ensures that the unit will be ready for use when called upon. A SR560 in storage should be "topped off" every three months with an overnight charge to maintain its batteries in peak condition.

CIRCUIT DESCRIPTION

DIFFERENTIAL LOW-NOISE FRONT END

Two high-impedance inputs A and B allow the instrument to operate in either single-ended or true differential modes. Relays K103 and K104 allow the inputs A and B to be individually grounded, while K101 selects AC or DC coupling. Inversion of the inputs is provided by relay K105. The input capacitances and R101 and R102 establish the front end's input impedance at 25 pF and 100 Mohms.

U106 is an NPD5564 low-noise matched FET pair which, along with U102 and U103 form the first differential amplifier stage. U102 compares the currents in the drain loads of U106, and U103 maintains the sum of those currents at a fixed level by varying the total current in both FETs. C109 provides open-loop compensation for U102, and front end gain is nominally established by the sum of R118 and R112 over the sum of R114 and R128. K102 is a gain switching relay which selects a front end gain of 2 or 10. In the gain of 2 position, gain to the next stage becomes 1 when R116 divides with the input attenuator to the next stage. For a gain of 10, relay K102 shorts the top of R115 and R128 together, essentially eliminating them from the gain loop. P103 allows adjustment of front-end offset, and P104 allows for offset compensation when in the low gain configuration. P102 allows adjustment of the front-end common-mode rejection ratio, along with P101 which adjusts the CMRR in the low gain configuration.

In the second gain stage, U105 is configured with a fixed gain of 10. By switching the input attenuation of this stage with DG444 U101, the overall gain of this stage can be computer selected as 2, 5, or 10. C111 provides high frequency compensation for U105. The output of this stage passes through all three sections of U104, a CMOS multiplexer that serves as the blanking control. The three parallel switches provide a low "on" resistance to select either the output of the second stage amplifier or ground as the input to the next stage, the first filter section.

CONFIGURABLE FILTERS AND GAIN

The two filter stages in the SR560 each consist of 16 R-C filters which can be configured as either high pass or low pass by a relay. In the following description, part references in parentheses refer to filter two. Relay K201, (K301) selects either the high-pass or low-pass configuration for all of the sixteen filters. The output of one R-C section is selected by multiplexer U202 or U203, (U301 or U302) and passed on to non-inverting buffer U202, (U303).

Approximately 80 pF input capacitance of the multiplexers is included in the calculation of the R-C time constants of the filters. The four highest frequency stages are not available as high-pass filters because of unacceptable attenuation of the signal that occurs when the filter capacitance forms a divider with the input capacitance of the multiplexers.

DG444 U205D, (U401A) is used to bypass the filter sections entirely and U101D, (U304D) is used to "reset" the filter stages by discharging them through R228, (R329).

U201, (U305) is the third, (fourth) gain stage with a fixed gain of 5. The input attenuator U205, (U304) allows setting the gain of these stages to 1, 2, or 5 under computer control.

OUTPUT STAGES

The fifth gain stage consists of op-amp U402 which is configured as a non-inverting amplifier with a gain of 5. U401 is a DG444 that again serves to switch the input attenuation of this stage for overall gains of 1, 2, or 5. Additionally, output offset adjustment is provided by this stage. U405B, half of an AD7528 dual 8-bit DAC is used to provide a ±5 volt offset voltage at the non-inverting input of U402. The front panel offset control also sums at this junction, and provides an offset voltage of ±5 V that is buffered by U407D.

Following amplifier U402 is the other half of the 8-bit DAC U405A, which along with op-amp U404 forms a digital gain vernier. This vernier is used in calibration to compensate for gain variances that occur with configuration changes such as input coupling and filter settings. This DAC also provides the front panel "uncal" gain vernier function.

The sixth and final gain stage consists of U403 and output buffer U406, configured for a gain of 5 and with input attenuator U409 to select overall gains of 1, 2, or 5. The LM6321, (U406) provides the output drive capability for both the 600 ohm and 50 ohm outputs.

OVERLOAD DETECTION

The overload detector constantly monitors the front end output, filter 1 output, U402 (after the second filter) output, and final stage output for excessive signal levels. Comparator U408 compares both positive and negative signal excursions against a 5 volt reference and lights the front panel overload indicator if any levels are excessive.

MICROPROCESSOR

The system processor U503 is a CMOS Z80 processor running at 4 MHz. The system clock consists of Schmitt trigger U506A and an R-C network. The oscillator is designed so that latch U508A can shut down the clock oscillator completely, thereby disabling all digital circuits in the amplifier so that no digital noise will be present. The processor and clock only run when a front panel key is pressed and instrument settings are to be changed, or while there is activity on the RS-232 port.

The SR560 uses a 16 K x 8 CMOS EPROM, (U504) containing system firmware and calibration bytes, along with a 2 K x 8 CMOS RAM, (U505) which is battery backed-up at all times to retain instrument settings.

U507 generates port strobes for system IO, and U510 provides a buffered data bus. The buffered data bus is active only during IO instructions to keep digital noise in the amplifier to a minimum while the processor is running.

U601 through U606 are control latches providing the 48 DC control lines that configure all of the instrument's hardware. U607 is an input buffer and takes data from the front panel and RS-232, as well as providing a processor input indicating line operation and address from SW601 for ganged RS-232 operation. SW601 additionally controls power to the front panel LEDs through positions 3 and 4.

BATTERY CHARGER AND PRE-REGULATORS

The 17 volt AC line transformer provides unregulated power for both amplifier operation and battery charging. Diode bridge D706 and filter capacitors C706 and C707 generate unregulated DC that is pre-regulated to ±12 VDC by U706 and U707 to take the place of the batteries when the instrument is operating on AC line power. Relay U705 switches the amplifier from battery to pre-regulated AC whenever the AC line cord is plugged in.

Diode bridge D710 and C709 and C710 provide unregulated DC to charge the batteries. U701 and U702 operates as "AC" regulators, limiting peak battery charging voltage. As there are two positive batteries and one negative battery, U701 is a LM350 regulator that provides twice the current of the LM317 negative battery regulator.

Charging is controlled by changing the set voltage of the regulators based on battery charge status. Flip-flop U703 determines whether the charge regulators will be set to 15.5 volts for a quick charge or 13.8 volts for a trickle or "maintain" charge by grounding the bottom of P701 and P702. C712 and R704 insure that the charger always powers up in the "quick" charge mode. P701 and P702 are provided to adjust the open circuit trickle charge voltage to 13.8 volts. D701 and D703 are blocking diodes for the charging circuits while not charging, and D707 and D708 are clamps to guard against battery polarity reversal.

Comparators U708 and U709 are LP365 micropower comparators that monitor the battery voltage. A resistive divider chain sets the four trip points for each comparator. D709 provides a stable 2.5 volt reference against which levels are compared. For each battery, three level indications are provided, and are decoded by multiplexer U704. The "trip" level is 14.5 volts. The trip outputs control the state of U703 and switch the bat-

tery charge voltage settings. The "low" level is 11.3 volts and activates the front panel low battery indicator. R730 provides some level hysteresis for the low battery indication to prevent oscillation around the trip point. The "dead" level is 10.7 volts and is used to disconnect the load from the batteries before they are damaged by an excessively deep discharge. Q701 and Q703 are power MOSFET switches used to disconnect battery power from the amplifier. Dead level hysteresis is provided by R724. R731 and D711 provide uninterrupted battery power to the system RAM so that stored instrument settings are retained when the power is switched off.

POWER REGULATORS

The +5 V and +10 V supplies are produced with three-terminal regulators U801 and U802, respectively. The -10 V supply is constructed of op-amp U803 and Q801, a N-channel MOSFET as the pass element. The +10 V supply serves as the reference for the -10 V supply through divider R807 and R806.

The power output banana jacks on the rear panel (J801 and J803) are connected to the pre-regulated voltages after the power switch and before the regulators. This output can provide up to 200 mA of power for use as an external bias source, etc. Under some conditions, these jacks may be used to supply the unit with external DC power.

U506D and U506B generate the TTL level input to the processor to indicate when the unit is operating on the AC line.

Capacitors C801 through C821 are logic supply bypass capacitors distributed throughout the printed circuit board.

REAR PANEL INTERFACES

Two optically isolated rear panel interfaces are provided on the SR560. The blanking input accepts a TTL-level signal and grounds the amplifier signal path after the front end for as long as the input is held high. The response time of the blanking input is typically "on" 5 µs after the rising edge and "off" 10 µs after the falling edge.

The RS-232 interface allows calibration and control of the instrument at 9600 baud. Data in and out on the connector are tied together, echoing data back to the sender. Hardware handshaking lines CTS, DSR, and CD are tied to DTR. Refer to **Appendix A-1** for information on remote programming of the SR560.

BATTERIES AND P.E.M.

The batteries used in the SR560 are of sealed lead-acid construction. There are three 12 volt, 1.9 amp-hour batteries, two of which serve as the positive power supply, and one of which serves as the negative power supply. Powering the SR560 alone, battery life should be greater than 20 hours. The batteries should last for more than 1000 charge / discharge cycles, provided the guidelines under the Usage section are followed. Two 3A, fast blow fuses on the rear panel protect the battery supplies and amplifier against excessive currents.

The power entry module (P.E.M.) contains the AC line fuse, RFI filter, and voltage selection card. To change the operating voltage of the unit, the voltage selector printed circuit card must be pulled out and reinserted into the P.E.M. with the desired operating voltage visible.

FRONT PANEL

The front panel contains the keypad pushbuttons, LED indicators and serial shift registers. The front panel pushbuttons are decoded in a 3 x 4 matrix fashion. The front panel LEDs are controlled by shift registers U1 through U5, which allow the 5 eight-bit control bytes to be serially shifted-in one bit at a time. The red overload LED is controlled directly from the output of the overload comparator.

The battery LED is a dual-color LED that is green when the unit is operating on battery power, and turns red when the low_batt signal is asserted.

The front panel output offset pot P1 is also mounted on the front panel printed circuit board.

CALIBRATION AND REPAIR

OFFSET ADJUSTMENT

The SR560's front-panel offset adjustment provides an easy way for the user to null the amplifier's DC offset. Use the **COUPLING** pushbutton to light the GND LED. Now, regardless of the **SOURCE** setting, the input to the amplifier is grounded internally. Insert a small screwdriver through the front-panel **OFFSET** hole and adjust the offset potentiometer until the DC offset of the amplifier (e.g. as viewed on a DVM) is zero. Finally, return to the desired coupling.

CALIBRATION

There are four pots which are used to calibrate the instrument. The pots adjust the front-end CMRR (Common Mode Rejection Ratio) and offset. These pots are located close to the front of the instrument, and may be accessed by removing the bottom cover.

These pots should be adjusted to optimize the CMRR or null the offset when the front-end FET is replaced. Two of the pots adjust the CMRR and offset when the front-end gain is x10, and two adjust the CMRR and offset when the front-end gain is x2. The x10 gain pots must be set first, followed by the x2 gain pots.

First, the front panel offset pot must be set to zero:

- Adjust front panel Offset pot to read 0 VDC on pin 14, U407.

Next adjust the offset and CMRR for the case where the front-end gain is x10. View the amplifier output on a scope and perform the following adjustments:

- Couple = GND, Gain = 5 k, LOW NOISE: adjust P103 to null DC and output.

Now use a function generator as the source of a common mode signal:

- Apply 1 kHz 1 Vp-p sine to both the A and B inputs.
- Couple = DC, source = A - B: adjust P102 to null sine wave output.

Now adjust the offset and CMRR for the case where the front-end gain is x2. View the amplifier output on a scope and perform the following adjustments:

- Couple = GND (remove signal from A and B inputs), Gain = 5 k, HIGH DR: adjust P104 to null DC and output.
- Apply 1 kHz 1 Vp-p sine to both the A and B inputs.
- Couple = DC, source = A - B: adjust P101 to null sine wave output.

NOTE: In the above procedures, the gain of the front-end (x10 or x2) is determined by the selection of LOW NOISE or HIGH DYNAMIC RESERVE.

FRONT END REPLACEMENT

The most commonly damaged component is the front-end FET (U106, National Semiconductor Corp. P/N NPD5564). It is located in an 8 pin DIP socket behind the relays near the input BNCs. If the instrument exhibits a constant overload, excessive drift or noise, or large input bias currents, it is likely that this component has been damaged.

When replacing the FET, be certain that all eight pins are inserted into the socket, and observe the orientation of pin #1. After replacement adjust the CMRR and offset per the calibration procedure. More severely damaged front-ends may require replacement of op-amp, U102.

BATTERY REPLACEMENT

After three to five years or about 1000 charge/discharge cycles, the sealed lead-acid batteries degrade. When the battery operation time shortens, or if the unit stays very warm for more than a day after it is plugged into the line, the batteries may require replacement.

The three batteries are a standard size which are available from several different distributors. All are 12 VDC with a charge capacity of about 2.0 Amp-hours, and measure 7.02" X 1.33" X 2.38". Two of the batteries are wired in parallel to provide the

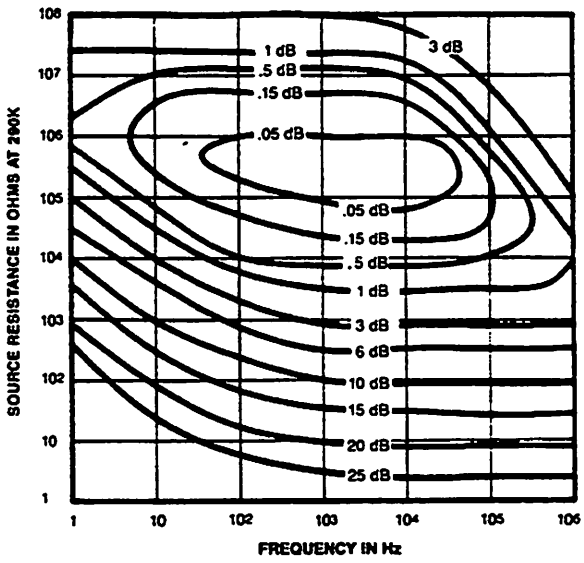
high current required for the positive supply. When replacing the batteries, take care to observe the polarities!

FUSE REPLACEMENT

There are three fuses on the back panel of the instrument. The fuse located inside the power entry module will blow if the unit draws excessive line current. Replace this fuse with the value indicated for your line voltage.

The other two fuses are in-line with the batteries. These fuses will blow if the rear panel ±12 VDC supplies are shorted, or if the unit sources or draws excessive current to or from the batteries.

NOISE CONTOURS



The noise contours shown above plot the noise figure as a function of source impedance and frequency. Noise Figure (NF) is defined as:

- NF = 20 log (Output noise / Gain X Source Thermal Noise)

A low noise figure means that the output noise is dominated by the thermal (Johnson) noise of the source. A high noise figure indicates that the amplifier's output noise is dominated by the amplifier's own noise, which is much larger than the thermal noise of the source.
The NF gets worse for low source resistances because the source's thermal noise gets very small, while the amplifier's input voltage noise stays relatively constant.

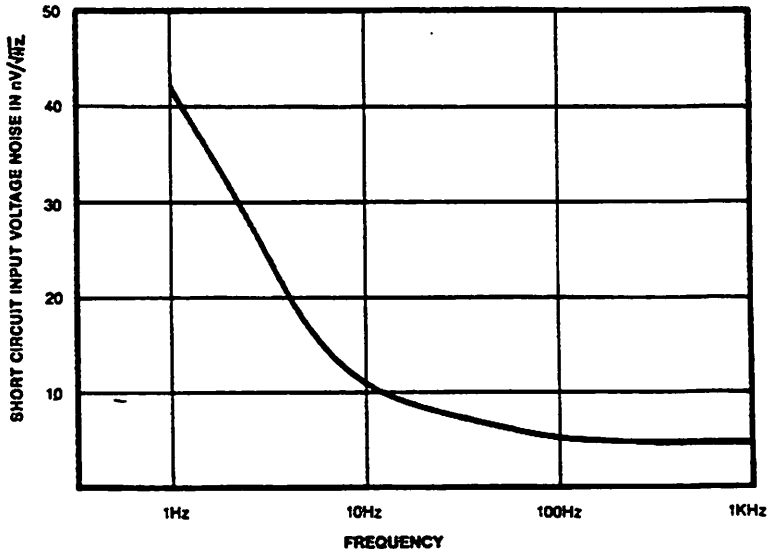
The NF gets worse for low frequencies and low source resistances because the amplifier's "1/f" noise is large relative to the thermal noise of the source.

The NF gets worse for large source impedances and high frequencies because the signal is attenuated (hence the gain reduced) by the shunting capacitance of the input.

Under no circumstances will adding source resistance reduce the amplifier's output noise! While this does improve the NF, it does so by making the source so noisy that the amplifier is quiet in comparison.

INPUT VOLTAGE NOISE

The amplifier's input voltage noise approximates that of a 1000 ohm resistor (about 4 nV / √ Hz). For source impedances below 1000 ohms, the output noise will be dominated by the amplifier's input voltage noise. A typical amplifier has an input voltage noise vs frequency as shown in the figure below. Notice that the voltage noise rises at lower frequencies ("1/f" noise).



DYNAMIC RESERVE

The dynamic reserve of the amplifier is a measure of how large a signal can be present at the input to the amplifier without causing an overload condition.

The definition of dynamic reserve is:

- DR (dB) = 20 log
  (Vin(f) w/o overload / Vin for full scale)

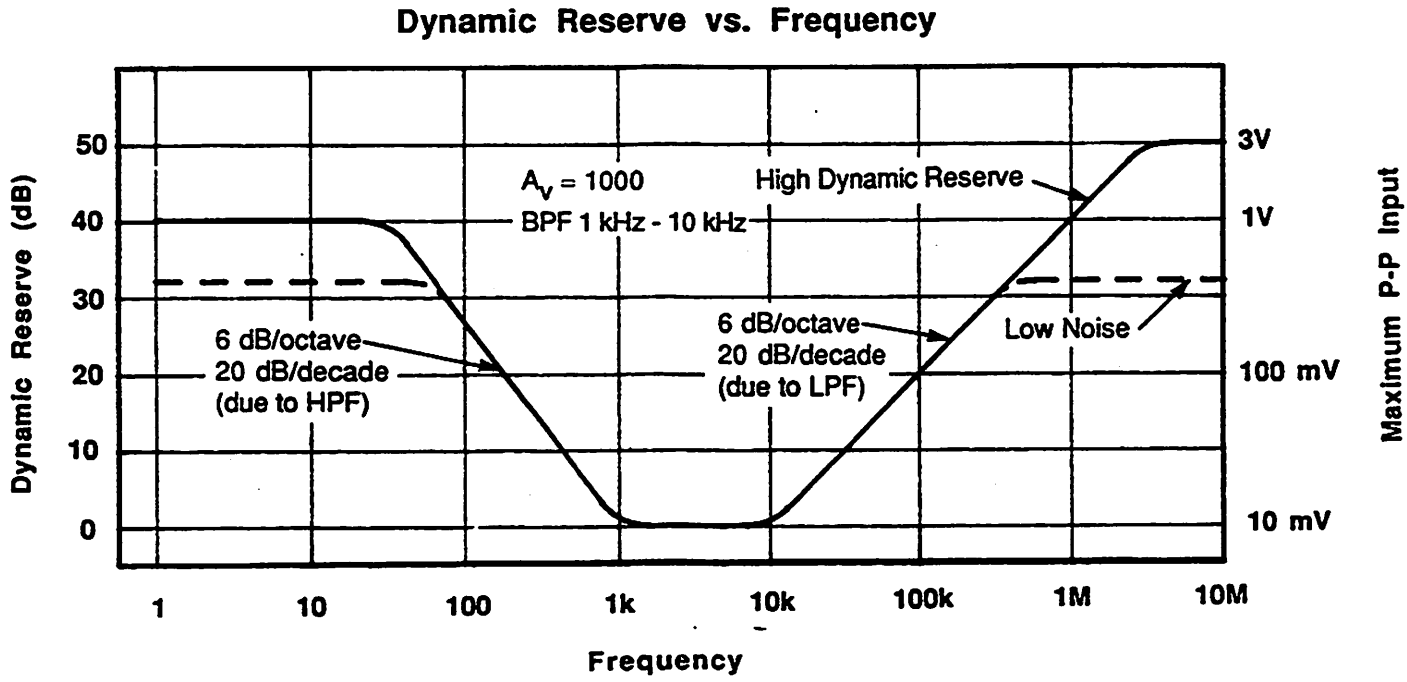
A full scale output voltage is 10 Vpp. Signals at the output (or at any stage) which exceed 10 Vpp cause an overload. The dynamic reserve is greater than 0 dB only when the filters are used to remove unwanted signals.

The dynamic reserve is a function of frequency and depends on the amplifier configuration (gain, filters and dynamic reserve setting). The figure below shows the dynamic reserve (and maximum input signal without overload) for a SR560 set to a gain of 1000, the high pass filter set to 1 kHz and the low pass filter set to 10 kHz (for a bandpass from 1 kHz to 10 kHz). The dynamic reserve characteristic is shown for both "High Dynamic Reserve" and "Low Noise" gain modes.

There are several features to note. In the bandpass region between 1 and 10 kHz the dynamic reserve is 0 dB. The dynamic reserve is 3 dB at the filter frequencies of 1 and 10 kHz. The dynamic reserve rises by 6 dB/oct (or 20 dB per decade) as the signal moves away from the pole frequency, since each RC filter attenuates the signal. If a faster roll-off for interfering signals were required, a 12 dB/octave HP or LP filter could be used.

The HIGH DR characteristic offers 16 dB more DR at low frequencies and 26 dB more at high frequencies. The high frequency DR is limited only by the maximum 3 Vpp limit of the input stage.

The maximum DR in the low noise mode is 36 dB. Since there is no gain between the HP and LP filters in the Low Noise gain mode, the DR is the same at very high frequencies and very low frequencies.



The input reference voltage noise for the High DR gain mode is about 10 nV / √ Hz, compared to 4 nV / √ Hz in the Low Noise gain mode. The table below summarizes the input referenced noise and maximum dynamic reserve for all gains.

Gain	Input Noise (nV/√Hz)	Maximum DR (dB 0)
1	60	0
2	40	0
5	25	6
10, LN	13	6
10, HDR	25	14
20, LN	11	6
20, HDR	25	20
50, LN	10	14
50, HDR	25	28
100, LN	4	14
100, HDR	20	34
200, LN	4	20
200, HDR	18	40
500, LN	4	28
500, HDR	15	48
1000, LN	4	34
1000, HDR	15	54
2000, LN	4	40
2000, HDR	10	52
5000, LN	4	48
5000, MDR	8	54
10000	4	54
20000	4	52
50000	4	54

APPENDIX A

REMOTE PROGRAMMING

Introduction

The SR560 is equipped with a standard DB-25 RS-232C connector on the rear panel for remote control of all instrument functions. The interface is configured as listen-only, 9600 baud DCE, 8 bit, no parity, 2 stop bits, and is optically isolated to prevent any noise or grounding problems.

Up to four SR560 amplifiers can be connected in parallel to the same RS-232 interface. Units sharing the same interface must have a unique address as set on dip switch SW601, accessible through the bottom cover of the unit. To set an instrument to one of the four available addresses, adjust positions one and two of dip switch SW601 as follows:

SW601 Pos. 2	SW601 Pos. 1	Address of unit
OFF	OFF	UNIT 0
OFF	ON	UNIT 1
ON	OFF	UNIT 2
ON	ON	UNIT 3

Commands

The following commands are obeyed by all SR560's that are addressed to listen. The LALL, LISN, and UNLS commands are always obeyed and control the address status of the SR560. Commands must end with a carriage return and line feed <CR> <LF>.

BLNK i — Operates amplifier blanking.
i = 0 = not blanked, 1 = blanked

CPLG i — Sets input coupling.
i = 0 = ground, 1 = DC, 2 = AC

DYNR i — Sets dynamic reserve.
i = 0 = low noise, 1 = high DR,
2 = calibration gains (defaults)

FLTM i — Sets filter mode.
i = 0 = bypass, 1 = 6 dB low pass,
2 = 12 dB low pass, 3 = 6 dB high pass, 4 = 12 dB highpass, 5 = band-pass

GAIN i — Sets the gain.
i = 0 - 14 = 1, 2, 5, ... 50 k gain

HFRQ i — Sets highpass filter frequency.
i = 0 - 11 sets frequency = 0.03 Hz to 10 kHz

INVT i — Sets the signal invert sense.
i = 0 = non-inverted, 1 = inverted

LALL — Listen all. Makes all attached SR560's listeners.

LISN i — Listen command. Makes SR560 with address i (0,1,2,3) a listener.

LFRQ i — Sets lowpass filter frequency.
i = 0 - 15 sets frequency = 0.03 Hz to 1 MHz

ROLD — Resets overload for 1/2 second.

SRCE i — Sets the input source.
i = 0 = A, 1 = A - B, 2 = B

UCAL i — Sets the vernier gain status.
i = 0 = cal'd gain, 1 = vernier gain

UCGN i — Sets the vernier gain to i %.
i = 0 to 100

UNLS — Unlisten. Unaddresses all attached SR560's.

*RST — Reset. Recalls default settings.

APPENDIX B

NOISE SOURCES AND CURES

Noise, random and uncorrelated fluctuations of electronic signals, finds its way into experiments in a variety of ways. Good laboratory practice can reduce noise sources to a manageable level, and the lock-in technique can be used to recover signals which may still be buried in noise.

Intrinsic Noise Sources

Johnson Noise

Arising from fluctuations of electron density in a resistor at finite temperature, these fluctuations give rise to a mean square noise voltage,

$$\bar{V}^2 = \int 4kT\,\mathrm{Re}[Z(f)]\,df = 4kTR\,\Delta f$$

where k = Boltzmann's constant, 1.38×10^{-23} J/°K; T is the absolute temperature in Kelvin; the real part of the impedance, Re[z(f)] is the resistance R; and we are looking at the noise source with a detector, or AC voltmeter, with a bandwidth of Δf in Hz. For a 1 MΩ resistor:

$$(\bar{V}^2)^{1/2} = 0.13\,\mu V/\sqrt{Hz}$$

To obtain the rms noise voltage that you would see across this 1MΩ resistor, we multiply $0.13\,\mu V/\sqrt{Hz}$ by the square root of the detector bandwidth. If, for example, we were looking at all frequencies between DC and 1 MHz, we would expect to see a rms Johnson noise of:

$$(\bar{V}^2)^{1/2} = 0.13\,\mu V/\sqrt{Hz} * (10^6\,Hz)^{1/2} = 130\,\mu V$$

'1/f Noise'

Arising from resistance fluctuations in a current carrying resistor, the mean squared noise voltage due to '1/f' noise is given by,

$$\bar{V}^2 = AR^2I^2\,\Delta f/f$$

where A is a dimensionless constant, 10^{-11} for carbon, R is the resistance, I the current, Δf the bandwidth of our detector, and f is the frequency to which the detector is tuned. For a carbon resistor carrying 10 mA with R = 1 k, Δf = f = 1 Hz, we have:

$$V_{noise} = 3\mu V\,rms$$

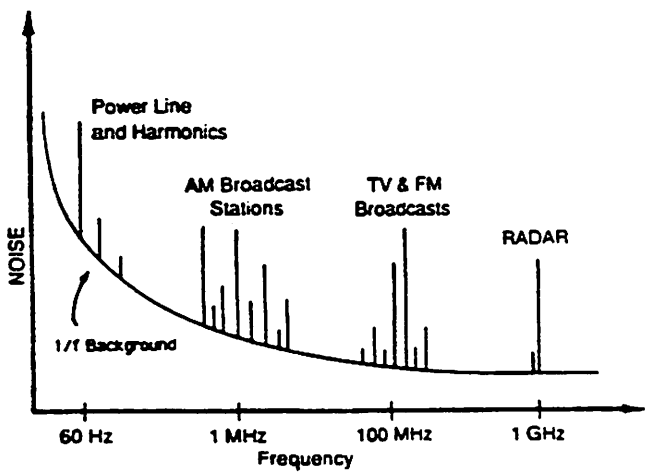
Others

Other noise sources include flicker noise found in vacuum tubes, and generation and recombination noise found in semiconductors.

All of these noise sources are incoherent. Thus, the total noise is the square root of the sum of the squares of all the incoherent noise sources.

Non-Essential Noise Sources

In addition to the "intrinsic" noise sources listed above there are a variety of "non-essential" noise sources, (i.e. those noise sources which can be minimized with good laboratory practice). It is worthwhile to look at what might be a typical noise spectrum encountered in the laboratory environment:

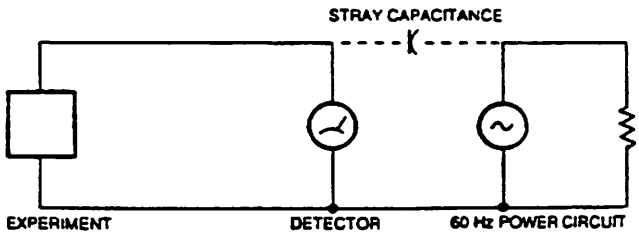


Noise Spectrum

Some of the non-essential noise sources appear in this spectrum as spikes on the intrinsic background. There are several ways which these noise sources work their way into an experiment.

Capacitive Coupling

A voltage on a nearby piece of apparatus (or operator) can couple to a detector via a stray capacitance. Although C_{stray} may be very small, the coupled in noise may still be larger than a weak experimental signal.



Capacitive Noise Coupling

To estimate the noise current through C_{stray} into the detector we have

$$i = C_{stray} \frac{dV}{dt} = j w C_{stray} V_{noise}$$

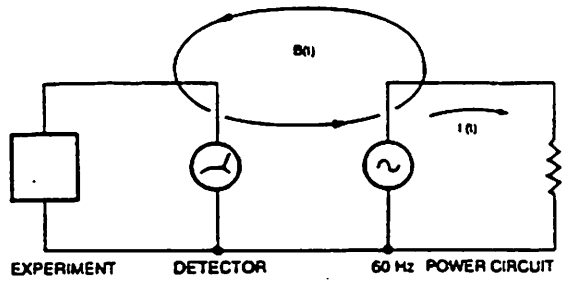
where a reasonable approximation to C_{stray} can be made by treating it as parallel plate capacitor. Here, w is the radian frequency of the noise source (perhaps $2 * \pi * 60$ Hz), V_{noise} is the noise voltage source amplitude (perhaps 120 VAC). For an area of A = $(.01\ m)^2$ and a distance of d = 0.1 m, the 'capacitor' will have a value of 0.009 pF and the resulting noise current will be 400 pA. This meager current is about 4000 times larger than the most sensitive current scale that is available on the SR510 lock-in.

Cures for capacitive coupling of noise signals include:

1) Remove or turn off the interfering noise source.

2) Measure voltages with low impedance sources and measure currents with high impedance sources to reduce the effect of i_{stray}.

3) Install capacitive shielding by placing both the experiment and the detector in a metal box.



Inductive Noise Coupling

Inductive Coupling

Here noise couples to the experiment via a magnetic field:

A changing current in a nearby circuit gives rise to a changing magnetic field which induces an emf in the loop connecting the detector to the experiment, (emf = $d\Phi_B/dt$). This is like a transformer, with the experiment-detector loop as the secondary winding.

Cures for inductively coupled noise include:

1) Remove or turn off the interfering noise source (difficult to do if the noise is a broadcast station).

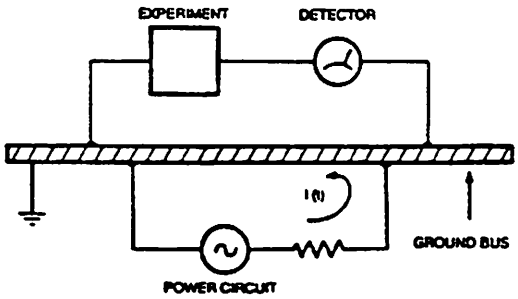
2) Reduce the area of the pick-up loop by using twisted pairs or coaxial cables, or even twisting the 2 coaxial cables used in differential hookups.

3) Use magnetic shielding to prevent the magnetic field from inducing an emf (at high frequencies a simple metal enclosure is adequate).

4) Measure currents, not voltages, from high impedance experiments.

Resistive Coupling (or 'Ground Loops')

Currents through common connections can give rise to noise voltages.



Resistive Coupling

Here, the detector is measuring the voltage across the experiment, plus the voltage due to the noise current passing through the finite resistance of the ground bus. This problem arises because we have used two different grounding points which are not at exactly the same potential. Some cures for ground loop problems include:

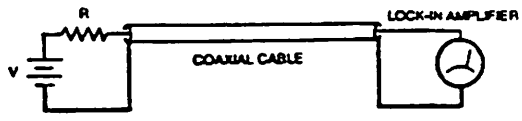
1) Ground everything to the same physical point.

2) Use a heavier ground bus to reduce the potential drop along the ground bus.

3) Remove sources of large currents from ground wires used for small signals.

Microphonics

Microphonics provides a path for mechanical noise to appear as electrical noise in a circuit or experiment. Consider the simple circuit below:



The capacitance of a coaxial cable is a function of its geometry so mechanical vibrations will cause the cable capacitance to vary with time.

Since C = Q / V, we have:

$$C\frac{dV}{dt} + V\frac{dC}{dt} = \frac{dQ}{dt} = i$$

So mechanical vibrations will cause a dC/dt which in turn gives rise to a current i, which will affect the detector. Ways to eliminate microphonic signals include:

1) Eliminate mechanical vibrations.

2) Tie down experimental cables so they will not sway to and fro.

3) Use a low noise cable that is designed to reduce microphonic effects.

Thermocouple Effect

The emf created by dissimilar metal junctions can give rise to many microvolts of DC potential, and can be a source of AC noise if the temperature of the junction is not held constant. This effect is large on the scale of many low level measurements.

SR560 COMPONENT PARTS LIST

FRONT PANEL PARTS LIST

REF.	SRS part#	VALUE	DESCRIPTION
D 1	3-00013-306	RED	LED, Rectangular
D 2	3-00012-306	GREEN	LED, Rectangular
D 3	3-00012-306	GREEN	LED, Rectangular
D 4	3-00012-306	GREEN	LED, Rectangular
D 5	3-00012-306	GREEN	LED, Rectangular
D 6	3-00012-306	GREEN	LED, Rectangular
D 7	3-00012-306	GREEN	LED, Rectangular
D 8	3-00012-306	GREEN	LED, Rectangular
D 9	3-00012-306	GREEN	LED, Rectangular
D 10	3-00175-306	YELLOW	LED, Rectangular
D 11	3-00012-306	GREEN	LED, Rectangular
D 12	3-00012-306	GREEN	LED, Rectangular
D 13	3-00012-306	GREEN	LED, Rectangular
D 14	3-00012-306	GREEN	LED, Rectangular
D 15	3-00012-306	GREEN	LED, Rectangular
D 16	3-00012-306	GREEN	LED, Rectangular
D 17	3-00012-306	GREEN	LED, Rectangular
D 18	3-00012-306	GREEN	LED, Rectangular
D 19	3-00012-306	GREEN	LED, Rectangular
D 20	3-00012-306	GREEN	LED, Rectangular
D 21	3-00012-306	GREEN	LED, Rectangular
D 22	3-00012-306	GREEN	LED, Rectangular
D 23	3-00012-306	GREEN	LED, Rectangular
D 24	3-00012-306	GREEN	LED, Rectangular
D 25	3-00012-306	GREEN	LED, Rectangular
D 26	3-00012-306	GREEN	LED, Rectangular
D 27	3-00012-306	GREEN	LED, Rectangular
D 28	3-00012-306	GREEN	LED, Rectangular
D 29	3-00012-306	GREEN	LED, Rectangular
D 30	3-00012-306	GREEN	LED, Rectangular
D 31	3-00012-306	GREEN	LED, Rectangular
D 32	3-00012-306	GREEN	LED, Rectangular
D 33	3-00012-306	GREEN	LED, Rectangular
D 34	3-00012-306	GREEN	LED, Rectangular
D 35	3-00012-306	GREEN	LED, Rectangular
D 36	3-00012-306	GREEN	LED, Rectangular
D 37	3-00012-306	GREEN	LED, Rectangular
D 38	3-00175-306	YELLOW	LED, Rectangular
D 39	3-00175-306	YELLOW	LED, Rectangular
D 40	3-00012-306	GREEN	LED, Rectangular
D 41	3-00012-306	GREEN	LED, Rectangular
D 42	3-00012-306	GREEN	LED, Rectangular
D 43	3-00004-301	1N4148	Diode
D 44	3-00004-301	1N4148	Diode
D 45	3-00004-301	1N4148	Diode
D 46	3-00004-301	1N4148	Diode
D 47	3-00377-305	GLPED2	LED, Rectangular, Bicolor
D 48	3-00004-301	1N4148	Diode
J 1	1-00035-130	20 PIN DIL	Connector, Male

N 1	4-00651-425	270X9	Resistor Network SIP 1/4W 2% (Common)
N 2	4-00651-425	270X9	Resistor Network SIP 1/4W 2% (Common)
N 3	4-00651-425	270X9	Resistor Network SIP 1/4W 2% (Common)
N 4	4-00336-425	270X5	Resistor Network SIP 1/4W 2% (Common)
N 5	4-00298-425	470X5	Resistor Network SIP 1/4W 2% (Common)
P 1	4-00611-452	100K	Pot, Multi Turn Trim, Mini
Q 1	3-00022-325	2N3906	Transistor, TO-92 Package
Q 2	3-00021-325	2N3904	Transistor, TO-92 Package
R 1	4-00057-401	220	Resistor, Carbon Film, 1/4W, 5%
R 2	4-00059-401	22K	Resistor, Carbon Film, 1/4W, 5%
R 3	4-00041-401	150	Resistor, Carbon Film, 1/4W, 5%
R 4	4-00081-401	470	Resistor, Carbon Film, 1/4W, 5%
SW1	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW2	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW3	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW4	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW5	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW6	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW7	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW8	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW9	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW10	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW11	2-00031-201	D6-01-05	Switch, Momentary Push Button
SW12	2-00031-201	D6-01-05	Switch, Momentary Push Button
U 1	3-00303-340	74HC164	Integrated Circuit (Thru-hole Pkg)
U 2	3-00303-340	74HC164	Integrated Circuit (Thru-hole Pkg)
U 3	3-00303-340	74HC164	Integrated Circuit (Thru-hole Pkg)
U 4	3-00303-340	74HC164	Integrated Circuit (Thru-hole Pkg)
U 5	3-00303-340	74HC164	Integrated Circuit (Thru-hole Pkg)
Z 0	7-00223-701	SR560-XX	Printed Circuit Board

MAIN BOARD PARTS LIST

REF.	SRS part#	VALUE	DESCRIPTION
BT1	6-00050-612	GB1219-36	Battery
BT2	6-00050-612	GB1219-36	Battery
BT3	6-00050-612	GB1219-36	Battery
C 101	5-00098-517	10U	Capacitor, Tantalum, 35V, 20%, Rad
C 102	5-00098-517	10U	Capacitor, Tantalum, 35V, 20%, Rad
C 103	5-00098-517	10U	Capacitor, Tantalum, 35V, 20%, Rad
C 104	5-00098-517	10U	Capacitor, Tantalum, 35V, 20%, Rad
C 106	5-00069-513	.1U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 107	5-00069-513	.1U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 108	5-00013-501	33P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 109	5-00013-501	33P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 110	5-00159-501	6.8P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 111	5-00019-501	68P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 112	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 113	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 114	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 115	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 116	5-00005-501	150P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 201	5-00019-501	68P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 202	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 203	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 204	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 205	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 206	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 208	5-00010-501	270P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 209	5-00061-513	.001U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 210	5-00063-513	.0033U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 211	5-00065-513	.01U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 212	5-00067-513	.033U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 213	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 214	5-00194-542	.47U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 215	5-00194-542	.47U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 216	5-00193-542	2.2U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 217	5-00193-542	2.2U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 218	5-00213-546	4.7U	Cap, Mini Electro, 100V, 20%, Rad
C 219	5-00213-546	4.7U	Cap, Mini Electro, 100V, 20%, Rad
C 220	5-00033-520	47U	Capacitor, Electrolytic, 16V, 20%, Rad
C 221	5-00033-520	47U	Capacitor, Electrolytic, 16V, 20%, Rad
C 222	5-00031-520	220U	Capacitor, Electrolytic, 16V, 20%, Rad
C 223	5-00031-520	220U	Capacitor, Electrolytic, 16V, 20%, Rad
C 224	5-00232-520	470U	Capacitor, Electrolytic, 16V, 20%, Rad
C 225	5-00232-520	470U	Capacitor, Electrolytic, 16V, 20%, Rad
C 226	5-00192-542	22U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 227	5-00192-542	22U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 228	5-00008-501	22P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 230	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 301	5-00017-501	47P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 302	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 303	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 304	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 306	5-00008-501	22P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 307	5-00010-501	270P	Capacitor, Ceramic Disc, 50V, 10%, SL

C 308	5-00061-513	.001U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 309	5-00063-513	.0033U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 310	5-00065-513	.01U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 311	5-00067-513	.033U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 312	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 313	5-00194-542	.47U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 314	5-00194-542	.47U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 315	5-00193-542	2.2U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 316	5-00193-542	2.2U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 317	5-00213-546	4.7U	Cap, Mini Electro, 100V, 20%, Rad
C 318	5-00213-546	4.7U	Cap, Mini Electro, 100V, 20%, Rad
C 319	5-00033-520	47U	Capacitor, Electrolytic, 16V, 20%, Rad
C 320	5-00033-520	47U	Capacitor, Electrolytic, 16V, 20%, Rad
C 321	5-00031-520	220U	Capacitor, Electrolytic, 16V, 20%, Rad
C 322	5-00031-520	220U	Capacitor, Electrolytic, 16V, 20%, Rad
C 323	5-00232-520	470U	Capacitor, Electrolytic, 16V, 20%, Rad
C 324	5-00232-520	470U	Capacitor, Electrolytic, 16V, 20%, Rad
C 325	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 326	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 327	5-00192-542	22U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 328	5-00192-542	22U MIN	Cap, Mini Electrolytic, 50V, 20% Radial
C 330	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 401	5-00017-501	47P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 402	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 403	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 404	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 405	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 406	5-00021-501	82P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 407	5-00107-530	1.8-6P	Capacitor, Variable, 200V, 5m
C 408	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 409	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 410	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 411	5-00002-501	100P	Capacitor, Ceramic Disc, 50V, 10%, SL
C 412	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 413	5-00061-513	.001U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 414	5-00061-513	.001U	Capacitor, Mylar/Poly, 50V, 5%, Rad
C 415	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 416	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 417	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 418	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 502	5-00104-530	3.5-20P	Capacitor, Variable, 200V, 5m
C 703	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 704	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 705	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 706	5-00234-551	1000U	Capacitor, Electrolytic,35V,20%, Ax
C 707	5-00234-551	1000U	Capacitor, Electrolytic,35V,20%, Ax
C 708	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 709	5-00227-526	100U	Capacitor, Electrolytic, 35V, 20%, Rad
C 710	5-00227-526	100U	Capacitor, Electrolytic, 35V, 20%, Rad
C 711	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 712	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 713	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 714	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 715	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 716	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 717	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U

C 801	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 802	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 803	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 804	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 805	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 806	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 807	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 808	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 809	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 810	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 811	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 812	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 813	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 814	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 815	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 816	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 817	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 818	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 819	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 820	5-00225-548	.1U AXIAL	Capacitor, Ceramic, 50V,+80/-20% Z5U AX
C 821	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 822	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 823	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 824	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 825	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 826	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 827	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 828	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 829	5-00100-517	2.2U	Capacitor, Tantalum, 35V, 20%, Rad
C 830	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 831	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
C 832	5-00023-529	.1U	Cap, Monolythic Ceramic, 50V, 20%, Z5U
CX506	5-00233-532	22P	Capacitor, Ceramic Disc, 50V, 10% NPO
D 101	3-00368-301	1N753A	Diode
D 201	3-00368-301	1N753A	Diode
D 202	3-00368-301	1N753A	Diode
D 301	3-00368-301	1N753A	Diode
D 302	3-00368-301	1N753A	Diode
D 401	3-00004-301	1N4148	Diode
D 402	3-00004-301	1N4148	Diode
D 403	3-00004-301	1N4148	Diode
D 404	3-00004-301	1N4148	Diode
D 405	3-00004-301	1N4148	Diode
D 406	3-00004-301	1N4148	Diode
D 407	3-00004-301	1N4148	Diode
D 408	3-00004-301	1N4148	Diode
D 501	3-00004-301	1N4148	Diode
D 502	3-00004-301	1N4148	Diode
D 503	3-00004-301	1N4148	Diode
D 505	3-00004-301	1N4148	Diode
D 701	3-00226-301	1N5822	Diode
D 702	3-00004-301	1N4148	Diode
D 703	3-00226-301	1N5822	Diode
D 704	3-00009-303	YELLOW	LED, T1 Package
D 705	3-00011-303	RED	LED, T1 Package
D 706	3-00062-340	KBP201G/BR-81D	Integrated Circuit (Thru-hole Pkg)

D 707	3-00226-301	1N5822	Diode
D 708	3-00226-301	1N5822	Diode
D 709	3-00306-340	LM385BZ-2.5	Integrated Circuit (Thru-hole Pkg)
D 710A	3-00391-301	MBR360	Diode
D 710B	3-00391-301	MBR360	Diode
D 711	3-00198-301	1N5231B	Diode
D 801	3-00226-301	1N5822	Diode
D 802	3-00004-301	1N4148	Diode
D 803	3-00004-301	1N4148	Diode
J 101	1-00073-120	INSL	Connector, BNC
J 102	1-00073-120	INSL	Connector, BNC
J 404	1-00073-120	INSL	Connector, BNC
J 405	1-00073-120	INSL	Connector, BNC
J 601	1-00035-130	20 PIN DIL	Connector, Male
J 805	1-00073-120	INSL	Connector, BNC
JP801	1-00016-160	RS232 25 PIN D	Connector, D-Sub, Right Angle PC, Female
K 101	3-00308-335	DS2E-ML2-DC5V	Relay
K 102	3-00308-335	DS2E-ML2-DC5V	Relay
K 103	3-00308-335	DS2E-ML2-DC5V	Relay
K 104	3-00308-335	DS2E-ML2-DC5V	Relay
K 105	3-00308-335	DS2E-ML2-DC5V	Relay
K 201	3-00308-335	DS2E-ML2-DC5V	Relay
K 301	3-00308-335	DS2E-ML2-DC5V	Relay
N 701	4-00497-421	1.5KX4	Res. Network, SIP, 1/4W,2% (Isolated)
N 702	4-00501-425	1.0MX5	Resistor Network SIP 1/4W 2% (Common)
P 101	4-00353-441	100	Pot, Multi-Turn Trim, 3/8" Square
P 102	4-00487-441	20	Pot, Multi-Turn Trim, 3/8" Square
P 103	4-00617-441	100K	Pot, Multi-Turn Trim, 3/8" Square
P 104	4-00617-441	100K	Pot, Multi-Turn Trim, 3/8" Square
P 701	4-00011-441	10K	Pot, Multi-Turn Trim, 3/8" Square
P 702	4-00011-441	10K	Pot, Multi-Turn Trim, 3/8" Square
Q 102	3-00022-325	2N3906	Transistor, TO-92 Package
Q 103	3-00022-325	2N3906	Transistor, TO-92 Package
Q 104	3-00022-325	2N3906	Transistor, TO-92 Package
Q 105	3-00022-325	2N3906	Transistor, TO-92 Package
Q 106	3-00022-325	2N3906	Transistor, TO-92 Package
Q 107	3-00022-325	2N3906	Transistor, TO-92 Package
Q 108	3-00022-325	2N3906	Transistor, TO-92 Package
Q 109	3-00022-325	2N3906	Transistor, TO-92 Package
Q 110	3-00022-325	2N3906	Transistor, TO-92 Package
Q 111	3-00022-325	2N3906	Transistor, TO-92 Package
Q 201	3-00022-325	2N3906	Transistor, TO-92 Package
Q 202	3-00022-325	2N3906	Transistor, TO-92 Package
Q 301	3-00022-325	2N3906	Transistor, TO-92 Package
Q 302	3-00022-325	2N3906	Transistor, TO-92 Package
Q 501	3-00021-325	2N3904	Transistor, TO-92 Package
Q 701	3-00310-329	MTP25N05	Voltage Reg., TO-220 (TAB) Package
Q 702	3-00887-325	MPS2907A	Transistor, TO-92 Package
Q 703	3-00374-329	MTP20P06	Voltage Reg., TO-220 (TAB) Package
Q 801	3-00376-329	MTP5N05	Voltage Reg., TO-220 (TAB) Package
R 2	4-00616-453	49.9	Resistor, 2W, 1%
R 101	4-00306-407	100M	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 102	4-00306-407	100M	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 103	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 104	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 105	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%

R 106	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 108	4-00169-407	249	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 109	4-00041-401	150	Resistor, Carbon Film, 1/4W, 5%
R 110	4-00141-407	100	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 111	4-00217-408	1.000K	Resistor, Metal Film, 1/8W, 0.1%, 25ppm
R 112	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 113	4-00301-408	110.0	Resistor, Metal Film, 1/8W, 0.1%, 25ppm
R 114	4-00301-408	110.0	Resistor, Metal Film, 1/8W, 0.1%, 25ppm
R 115	4-00619-408	909.0	Resistor, Metal Film, 1/8W, 0.1%, 25ppm
R 116	4-00193-407	499	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 117	4-00528-408	499.0	Resistor, Metal Film, 1/8W, 0.1%, 25ppm
R 118	4-00217-408	1.000K	Resistor, Metal Film, 1/8W, 0.1%, 25ppm
R 119	4-00544-407	165	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 120	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 121	4-00203-407	75.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 122	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 123	4-00215-407	909	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 124	4-00141-407	100	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 125	4-00192-407	49.9K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 126	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 127	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 128	4-00619-408	909.0	Resistor, Metal Film, 1/8W, 0.1%, 25ppm
R 129	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 130	4-00031-401	100	Resistor, Carbon Film, 1/4W, 5%
R 131	4-00528-408	499.0	Resistor, Metal Film, 1/8W, 0.1%, 25ppm
R 132	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 133	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 134	4-00102-401	75K	Resistor, Carbon Film, 1/4W, 5%
R 135	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 136	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 137	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 201	4-00516-407	14.3K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 202	4-00164-407	20.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 203	4-00516-407	14.3K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 204	4-00168-407	22.6K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 205	4-00516-407	14.3K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 206	4-00168-407	22.6K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 207	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 208	4-00168-407	22.6K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 209	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 210	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 211	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 212	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 213	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 214	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 215	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 216	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 217	4-00325-407	845	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 218	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 219	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 220	4-00296-407	604	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 221	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 222	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 223	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 224	4-00198-407	6.65K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 225	4-00158-407	2.00K	Resistor, Metal Film, 1/8W, 1%, 50PPM

R 226	4-00048-401	2.2K	Resistor, Carbon Film, 1/4W, 5%
R 227	4-00048-401	2.2K	Resistor, Carbon Film, 1/4W, 5%
R 228	4-00031-401	100	Resistor, Carbon Film, 1/4W, 5%
R 229	4-00305-401	4.3K	Resistor, Carbon Film, 1/4W, 5%
R 301	4-00516-407	14.3K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 302	4-00164-407	20.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 303	4-00516-407	14.3K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 304	4-00168-407	22.6K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 305	4-00516-407	14.3K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 306	4-00168-407	22.6K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 307	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 308	4-00168-407	22.6K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 309	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 310	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 311	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 312	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 313	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 314	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 315	4-00325-407	845	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 316	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 317	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 318	4-00296-407	604	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 319	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 320	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 321	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 322	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 323	4-00600-407	15.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 324	4-00198-407	6.65K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 325	4-00158-407	2.00K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 326	4-00048-401	2.2K	Resistor, Carbon Film, 1/4W, 5%
R 327	4-00048-401	2.2K	Resistor, Carbon Film, 1/4W, 5%
R 328	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 329	4-00031-401	100	Resistor, Carbon Film, 1/4W, 5%
R 330	4-00065-401	3.3K	Resistor, Carbon Film, 1/4W, 5%
R 401	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 402	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 403	4-00325-407	845	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 404	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 405	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 406	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 407	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 408	4-00317-407	422	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 409	4-00296-407	604	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 410	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 411	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 412	4-00296-407	604	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 413	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 415	4-00165-407	200	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 416	4-00555-407	590	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 417	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 418	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 419	4-00138-407	10.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 420	4-00188-407	4.99K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 421	4-00138-407	10.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 422	4-00186-407	4.22K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 423	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%

R 424	4-00186-407	4.22K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 425	4-00141-407	100	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 426	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 427	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 428	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 429	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 430	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 431	4-00022-401	1.0M	Resistor, Carbon Film, 1/4W, 5%
R 432	4-00022-401	1.0M	Resistor, Carbon Film, 1/4W, 5%
R 433	4-00138-407	10.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 434	4-00138-407	10.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 435	4-00138-407	10.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 436	4-00138-407	10.0K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 437	4-00057-401	220	Resistor, Carbon Film, 1/4W, 5%
R 438	4-00616-453	49.9	Resistor, 2W, 1%
R 439	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 440	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 441	4-00030-401	10	Resistor, Carbon Film, 1/4W, 5%
R 442	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 501	4-00084-401	5.1K	Resistor, Carbon Film, 1/4W, 5%
R 502	4-00027-401	1.5K	Resistor, Carbon Film, 1/4W, 5%
R 503	4-00027-401	1.5K	Resistor, Carbon Film, 1/4W, 5%
R 602	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 603	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 701	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 702	4-00088-401	51K	Resistor, Carbon Film, 1/4W, 5%
R 703	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 704	4-00022-401	1.0M	Resistor, Carbon Film, 1/4W, 5%
R 705	4-00169-407	249	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 706	4-00042-401	15K	Resistor, Carbon Film, 1/4W, 5%
R 707	4-00042-401	15K	Resistor, Carbon Film, 1/4W, 5%
R 708	4-00376-407	2.87K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 709	4-00169-407	249	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 710	4-00058-401	220K	Resistor, Carbon Film, 1/4W, 5%
R 711	4-00035-401	10M	Resistor, Carbon Film, 1/4W, 5%
R 712	4-00035-401	10M	Resistor, Carbon Film, 1/4W, 5%
R 713	4-00612-407	768K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 714	4-00278-407	10.7K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 715	4-00576-407	17.8K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 716	4-00386-407	30.9K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 717	4-00614-407	174K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 718	4-00613-407	147K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 719	4-00363-407	21.5K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 720	4-00383-407	12.7K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 721	4-00615-407	8.25K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 722	4-00207-407	806K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 723	4-00021-401	1.0K	Resistor, Carbon Film, 1/4W, 5%
R 724	4-00032-401	100K	Resistor, Carbon Film, 1/4W, 5%
R 725	4-00169-407	249	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 726	4-00169-407	249	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 727	4-00582-407	2.15K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 728	4-00582-407	2.15K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 729	4-00309-407	3.32K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 730	4-00022-401	1.0M	Resistor, Carbon Film, 1/4W, 5%
R 731	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 801	4-00031-401	100	Resistor, Carbon Film, 1/4W, 5%

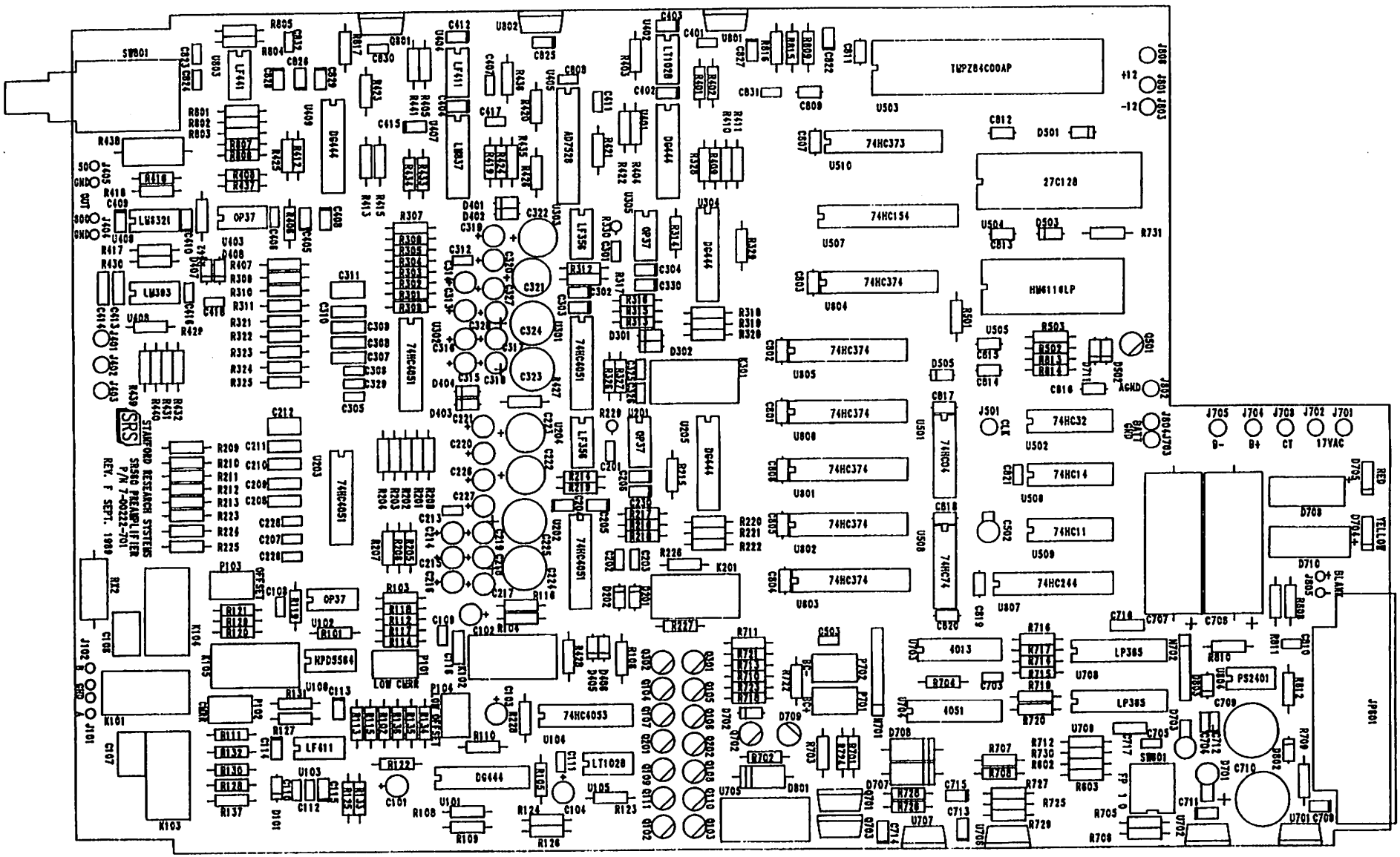
R 802	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 803	4-00034-401	10K	Resistor, Carbon Film, 1/4W, 5%
R 804	4-00192-407	49.9K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 805	4-00192-407	49.9K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 806	4-00192-407	49.9K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 807	4-00155-407	150K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 808	4-00062-401	270	Resistor, Carbon Film, 1/4W, 5%
R 809	4-00056-401	22	Resistor, Carbon Film, 1/4W, 5%
R 810	4-00087-401	510	Resistor, Carbon Film, 1/4W, 5%
R 811	4-00063-401	3.0K	Resistor, Carbon Film, 1/4W, 5%
R 812	4-00027-401	1.5K	Resistor, Carbon Film, 1/4W, 5%
R 813	4-00094-401	6.8K	Resistor, Carbon Film, 1/4W, 5%
R 814	4-00079-401	4.7K	Resistor, Carbon Film, 1/4W, 5%
R 815	4-00142-407	100K	Resistor, Metal Film, 1/8W, 1%, 50PPM
R 816	4-00092-401	56K	Resistor, Carbon Film, 1/4W, 5%
R 817	4-00022-401	1.0M	Resistor, Carbon Film, 1/4W, 5%
SO102	1-00173-150	8 PIN MACH	Socket, THRU-HOLE
SO106	1-00173-150	8 PIN MACH	Socket, THRU-HOLE
SO504	1-00026-150	28 PIN 600 MIL	Socket, THRU-HOLE
SW601	2-00008-207	SPSTX4	Switch, DIP
SW801	2-00023-218	DPDT	Switch, Panel Mount, Power, Rocker
T 1	6-00067-610	SR560	Transformer
U 101	3-00371-340	DG444	Integrated Circuit (Thru-hole Pkg)
U 102	3-00382-340	OP37	Integrated Circuit (Thru-hole Pkg)
U 103	3-00090-340	LF411	Integrated Circuit (Thru-hole Pkg)
U 104	3-00385-340	74HC4053	Integrated Circuit (Thru-hole Pkg)
U 105	3-00297-340	LT1028	Integrated Circuit (Thru-hole Pkg)
U 106	3-00246-340	NPD5564	Integrated Circuit (Thru-hole Pkg)
U 201	3-00382-340	OP37	Integrated Circuit (Thru-hole Pkg)
U 202	3-00270-340	74HC4051	Integrated Circuit (Thru-hole Pkg)
U 203	3-00270-340	74HC4051	Integrated Circuit (Thru-hole Pkg)
U 204	3-00189-340	LF356	Integrated Circuit (Thru-hole Pkg)
U 205	3-00371-340	DG444	Integrated Circuit (Thru-hole Pkg)
U 301	3-00270-340	74HC4051	Integrated Circuit (Thru-hole Pkg)
U 302	3-00270-340	74HC4051	Integrated Circuit (Thru-hole Pkg)
U 303	3-00189-340	LF356	Integrated Circuit (Thru-hole Pkg)
U 304	3-00371-340	DG444	Integrated Circuit (Thru-hole Pkg)
U 305	3-00382-340	OP37	Integrated Circuit (Thru-hole Pkg)
U 401	3-00371-340	DG444	Integrated Circuit (Thru-hole Pkg)
U 402	3-00297-340	LT1028	Integrated Circuit (Thru-hole Pkg)
U 403	3-00382-340	OP37	Integrated Circuit (Thru-hole Pkg)
U 404	3-00090-340	LF411	Integrated Circuit (Thru-hole Pkg)
U 405	3-00241-340	AD7528JN	Integrated Circuit (Thru-hole Pkg)
U 406	3-00383-340	LM6321	Integrated Circuit (Thru-hole Pkg)
U 407	3-00243-340	LM837	Integrated Circuit (Thru-hole Pkg)
U 408	3-00143-340	LM393	Integrated Circuit (Thru-hole Pkg)
U 409	3-00371-340	DG444	Integrated Circuit (Thru-hole Pkg)
U 501	3-00155-340	74HC04	Integrated Circuit (Thru-hole Pkg)
U 502	3-00045-340	74HC32	Integrated Circuit (Thru-hole Pkg)
U 503	3-00298-340	Z80H	Integrated Circuit (Thru-hole Pkg)
U 505	3-00081-341	2KX8-100	STATIC RAM, I.C.
U 506	3-00039-340	74HC14	Integrated Circuit (Thru-hole Pkg)
U 507	3-00158-340	74HC154N	Integrated Circuit (Thru-hole Pkg)
U 508	3-00049-340	74HC74	Integrated Circuit (Thru-hole Pkg)
U 509	3-00277-340	74HC11	Integrated Circuit (Thru-hole Pkg)
U 510	3-00259-340	74HCT373	Integrated Circuit (Thru-hole Pkg)

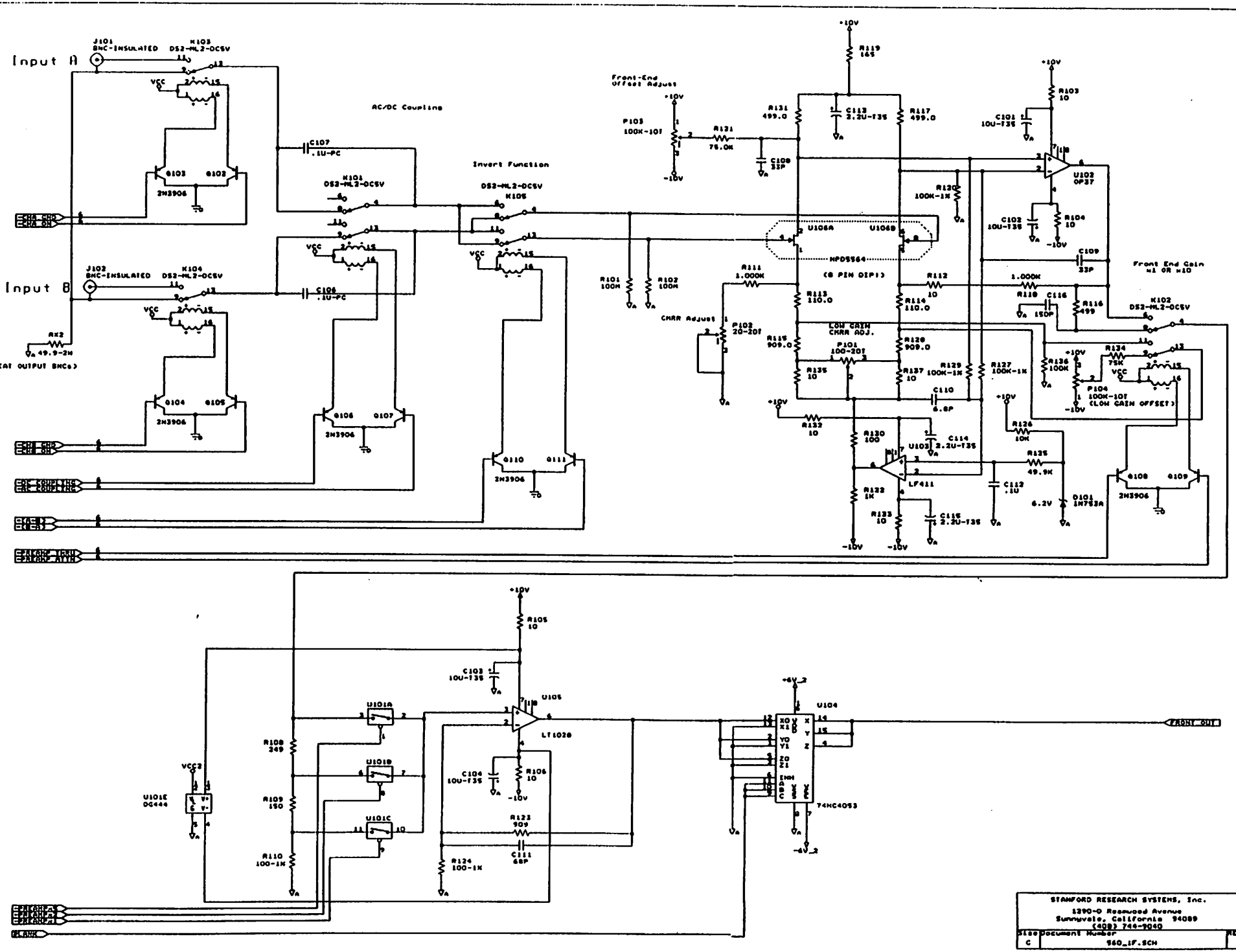
U 601	3-00046-340	74HC374	Integrated Circuit (Thru-hole Pkg)
U 602	3-00046-340	74HC374	Integrated Circuit (Thru-hole Pkg)
U 603	3-00046-340	74HC374	Integrated Circuit (Thru-hole Pkg)
U 604	3-00046-340	74HC374	Integrated Circuit (Thru-hole Pkg)
U 605	3-00046-340	74HC374	Integrated Circuit (Thru-hole Pkg)
U 606	3-00046-340	74HC374	Integrated Circuit (Thru-hole Pkg)
U 607	3-00044-340	74HC244	Integrated Circuit (Thru-hole Pkg)
U 701	3-00384-329	LM350T	Voltage Reg., TO-220 (TAB) Package
U 702	3-00141-329	LM337T	Voltage Reg., TO-220 (TAB) Package
U 703	3-00067-340	CD4013	Integrated Circuit (Thru-hole Pkg)
U 704	3-00152-340	CD4051	Integrated Circuit (Thru-hole Pkg)
U 705	3-00239-335	HS-212-12	Relay
U 706	3-00149-329	LM317T	Voltage Reg., TO-220 (TAB) Package
U 707	3-00141-329	LM337T	Voltage Reg., TO-220 (TAB) Package
U 708	3-00275-340	LP365	Integrated Circuit (Thru-hole Pkg)
U 709	3-00275-340	LP365	Integrated Circuit (Thru-hole Pkg)
U 801	3-00112-329	7805	Voltage Reg., TO-220 (TAB) Package
U 802	3-00307-340	LM2940T-10	Integrated Circuit (Thru-hole Pkg)
U 803	3-00090-340	LF411	Integrated Circuit (Thru-hole Pkg)
U 804	3-00250-340	PS2401A-2	Integrated Circuit (Thru-hole Pkg)
Z 0	0-00014-002	6J4	Power_Entry Hardware
Z 0	0-00017-002	TRANSCOVER	Power_Entry Hardware
Z 0	0-00042-010	4-40 HEX	Nut, Hex
Z 0	0-00043-011	4-40 KEP	Nut, Kep
Z 0	0-00048-011	6-32 KEP	Nut, Kep
Z 0	0-00077-030	3/16"X5/16"NYLN	Spacer
Z 0	0-00079-031	4-40X3/16 M/F	Standoff
Z 0	0-00089-033	4"	Tie
Z 0	0-00096-041	#4 SPLIT	Washer, Split
Z 0	0-00109-050	1-1/2" #18	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	0-00111-053	1-3/4"#24B	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00122-053	2-1/4" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00126-053	3-1/2" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00128-053	4" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00136-053	8-1/2" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00153-057	GROMMET2	Grommet
Z 0	0-00209-021	4-40X3/8PP	Screw, Panhead Phillips
Z 0	0-00231-043	#4 SHOULDER	Washer, nylon
Z 0	0-00233-000	HANDLE1	Hardware, Misc.
Z 0	0-00237-016	F1404	Power Button
Z 0	0-00240-026	4-40X3/8PF	Screw, Black, All Types
Z 0	0-00242-026	8-32X1/4PF	Screw, Black, All Types
Z 0	0-00243-003	TO-220	Insulators
Z 0	0-00249-021	6-32X1-1/2PP	Screw, Panhead Phillips
Z 0	0-00256-043	#6 SHOULDER	Washer, nylon
Z 0	0-00259-021	4-40X1/2"PP	Screw, Panhead Phillips
Z 0	0-00268-052	6-1/2" #22 BL	Wire #22 UL1007
Z 0	0-00284-025	10-32X1/2	Screw, Allen Head
Z 0	0-00299-000	1/8" ADHES TAPE	Hardware, Misc.
Z 0	0-00312-000	FUSEHOLDER	Hardware, Misc.
Z 0	0-00321-035	BLACK	BANANA JACK
Z 0	0-00322-035	RED	BANANA JACK
Z 0	0-00323-035	GREEN	BANANA JACK
Z 0	0-00324-035	WHITE	BANANA JACK
Z 0	0-00325-032	2-520182-2	Termination
Z 0	0-00327-050	8" #18 WHITE	Wire #18 UL1007 Stripped 3/8x3/8 No Tin

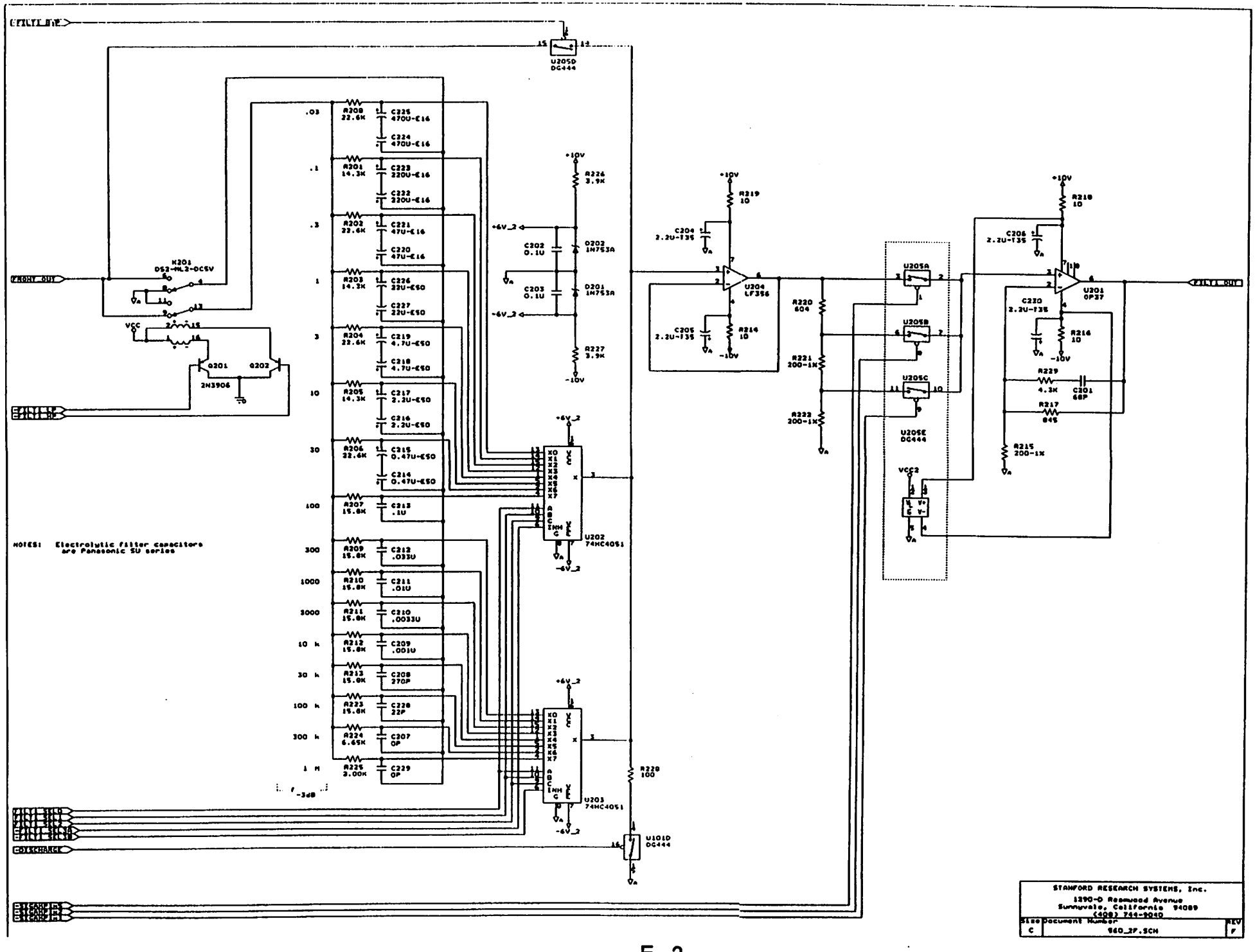
Z 0	0-00328-050	8" #18 RED	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	0-00329-050	8" #18 BLACK	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	0-00330-050	5-1/2" #18	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	0-00333-052	6" #22	Wire #22 UL1007
Z 0	0-00334-052	1-3/4" #22	Wire #22 UL1007
Z 0	0-00350-053	2-1/4" #24	Wire #24 UL1007 Strip 1/4x1/4 Tin
Z 0	0-00355-050	20" #18 RED	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	0-00466-050	23" #18 BLACK	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	0-00523-048	5-5/8" #18	Wire, #18 UL1015 Strip 3/8 x 3/8 No Tin
Z 0	0-00524-048	8-1/4" #18	Wire, #18 UL1015 Strip 3/8 x 3/8 No Tin
Z 0	0-00666-050	23" #18 WHITE	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	0-00667-050	20" #18 WHITE	Wire #18 UL1007 Stripped 3/8x3/8 No Tin
Z 0	1-00124-178	4 PIN	Connector Housing, Plug
Z 0	1-00125-179	4 PIN	Connector Housing, Receptacle
Z 0	1-00126-176	.062" DIAM	Terminal, Male
Z 0	1-00127-177	.062" DIAM	Terminal, Female
Z 0	1-00128-171	20 COND	Cable Assembly, Ribbon
Z 0	4-00541-435	130V/1200A	Varistor, Zinc Oxide Nonlinear Resistor
Z 0	5-00027-503	.01U	Capacitor, Ceramic Disc, 50V, 20%, Z5U
Z 0	6-00004-611	1A 3AG	Fuse
Z 0	6-00074-611	3A 3AG	Fuse
Z 0	7-00194-715	PS300-38	Bracket
Z 0	7-00201-720	SR500-32	Fabricated Part
Z 0	7-00222-701	SR560-XX	Printed Circuit Board
Z 0	7-00232-709	SR560-4	Lexan Overlay
Z 0	7-00251-720	SR560-21	Fabricated Part
Z 0	7-00252-720	SR560-23-25	Fabricated Part
Z 0	7-00257-720	SR560-20	Fabricated Part
Z 0	7-00258-720	SR560-26	Fabricated Part
Z 0	7-00680-720	PS300-52	Fabricated Part
Z 0	7-00795-720	BATTERY PAN	Fabricated Part
Z 0	7-00796-720	BATTERY RETAINR	Fabricated Part
Z 0	9-00127-907	1/2" CLEAR	Shrink Tubing
Z 0	9-00267-917	GENERIC	Product Labels
Z 0	9-00792-917	EC WARNING	Product Labels

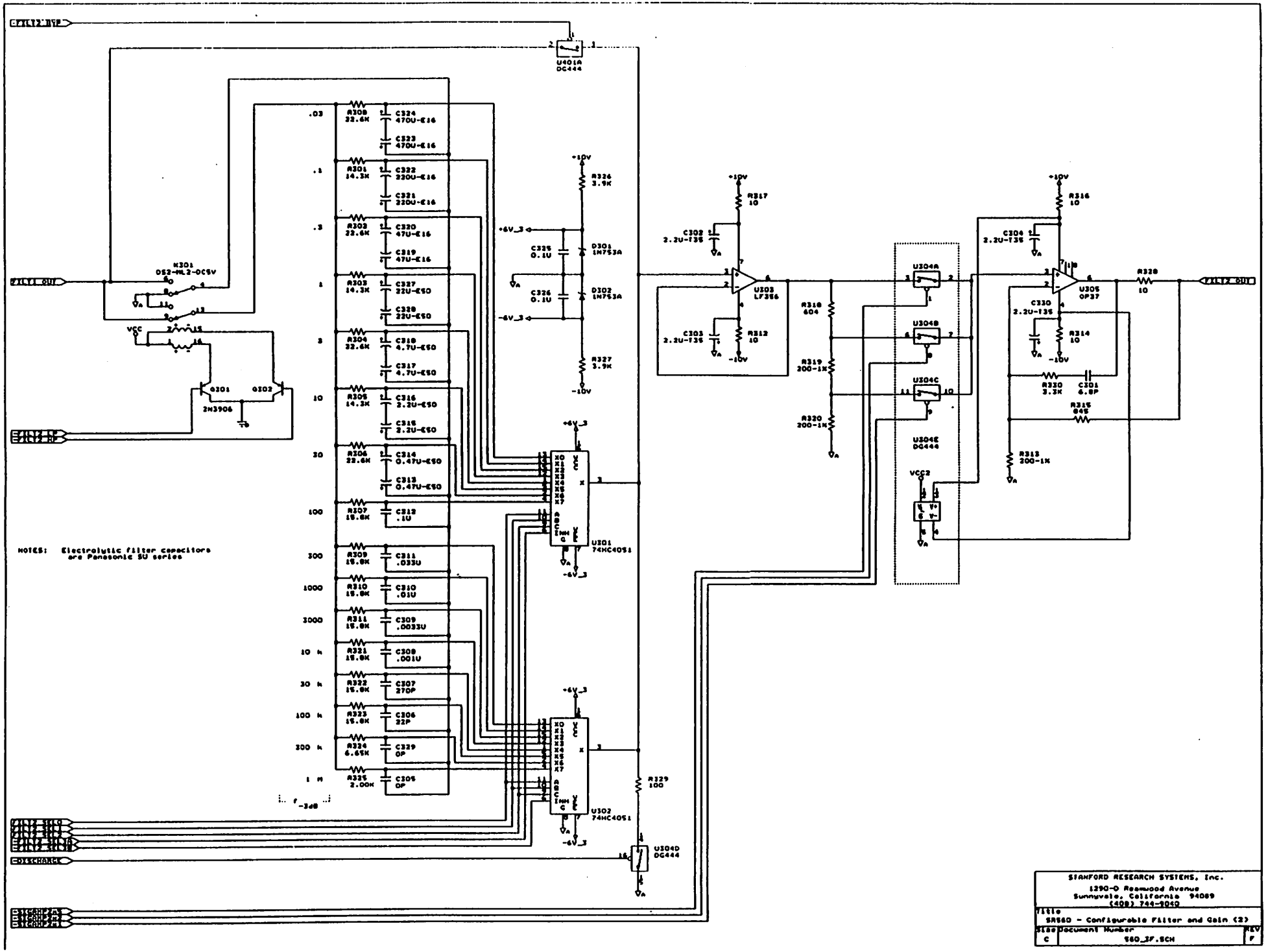
MISCELLANEOUS PARTS

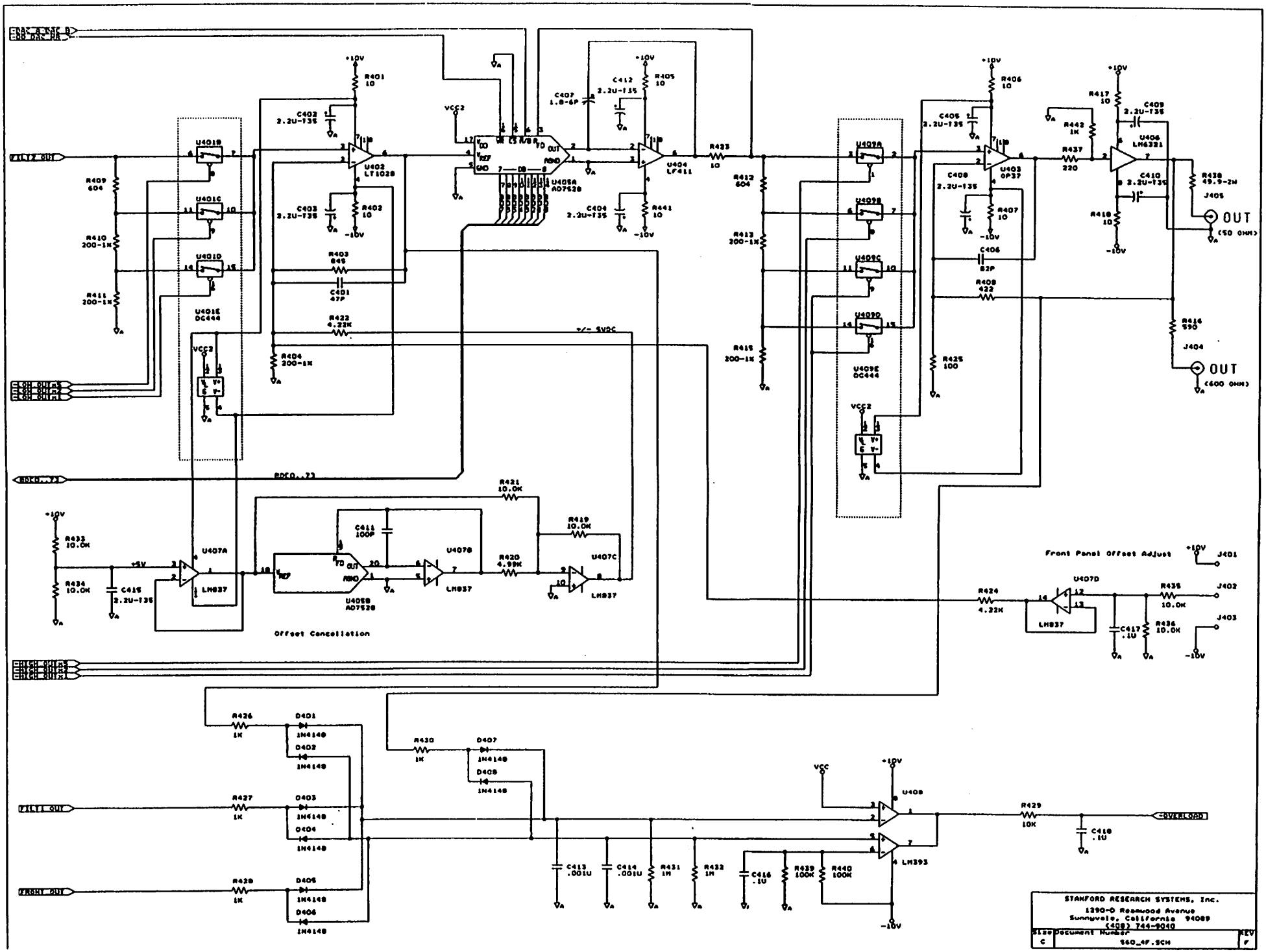
REF.	SRS part#	VALUE	DESCRIPTION
U 504	3-00305-342	8KX8-250	EPROM/PROM, I.C.
Z 0	0-00150-026	4-40X1/4PF	Screw, Black, All Types
Z 0	0-00179-000	RIGHT FOOT	Hardware, Misc.
Z 0	0-00180-000	LEFT FOOT	Hardware, Misc.
Z 0	0-00185-021	6-32X3/8PP	Screw, Panhead Phillips
Z 0	0-00204-000	REAR FOOT	Hardware, Misc.
Z 0	0-00248-026	10-32X3/8TRUSSP	Screw, Black, All Types
Z 0	0-00315-021	6-32X7/16 PP	Screw, Panhead Phillips
Z 0	0-00326-026	8-32X1/4PP	Screw, Black, All Types
Z 0	7-00122-720	DG535-36	Fabricated Part
Z 0	7-00217-735	PS300-40	Injection Molded Plastic
Z 0	7-00259-720	SR560-28	Fabricated Part
Z 0	7-00260-720	SR560-27	Fabricated Part

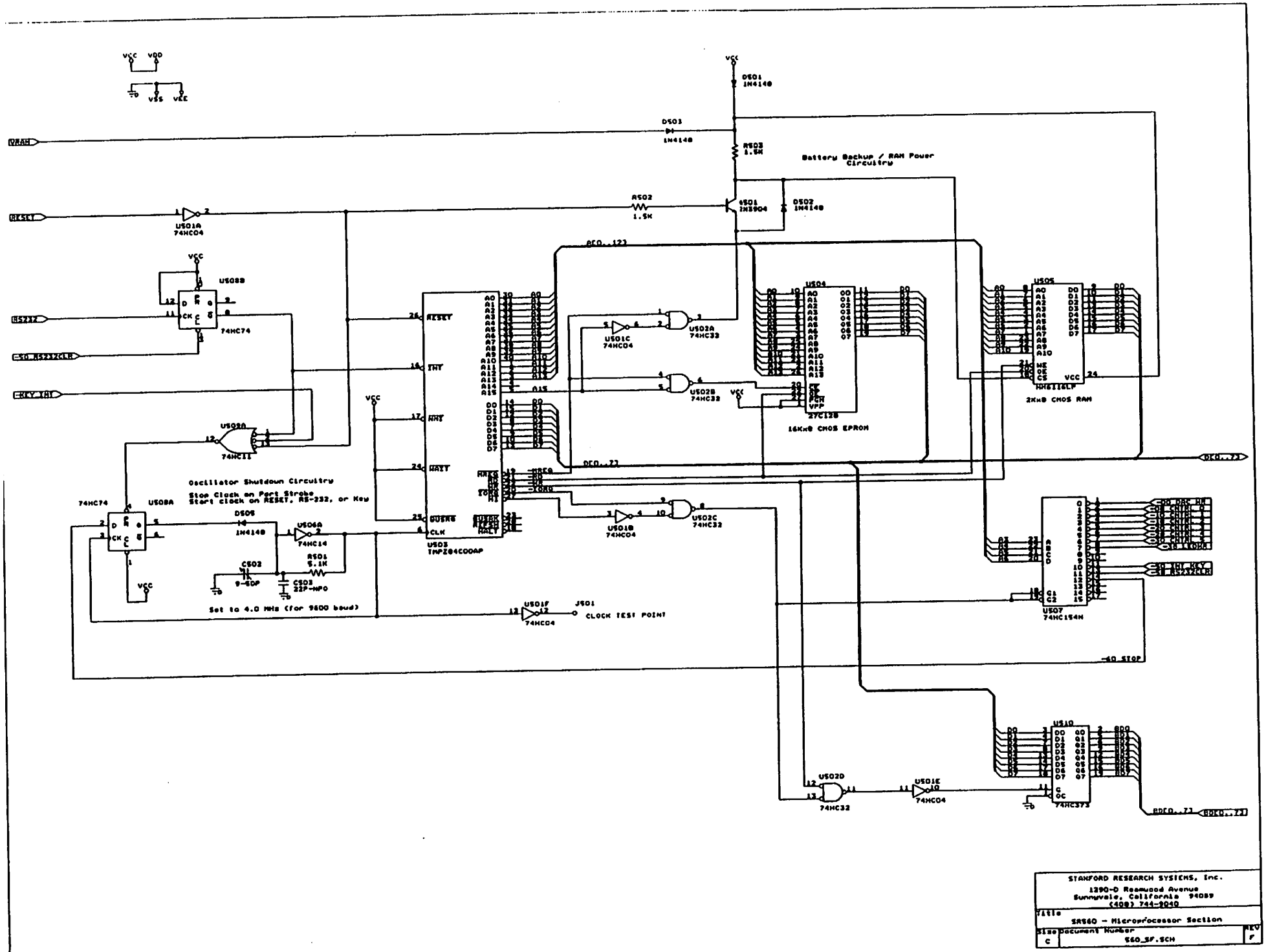

SRS
STANFORD RESEARCH SYSTEMS
SR560 PREAMPLIFIER
P/N 7-00222-701
REV. F SEPT. 1989
TWPZ84C00AP
27C128
74HC373
74HC154
74HC374
HM6116LP
74HC32
74HC14
74HC11
74HC244
74HC04
74HC4051
74HC4053
LP365
PS2401
4013
4051
OP37
LM6321
LM393
LF411
LF441
LF356
LT1028
AD7528
DG444
LM837
RED
YELLOW
BLANK
+12
-12
AGND
17VAC
J705
J704
J703
J702
J701
J706
J707
J708
J709
J710
J711
J712
J713
J714
J715
J716
J717
J718
J719
J720
J721
J722
J723
J724
J725
J726
J727
J728
J729
J730
J731
J732
J733
J734
J735
J736
J737
J738
J739
J740
J741
J742
J743
J744
J745

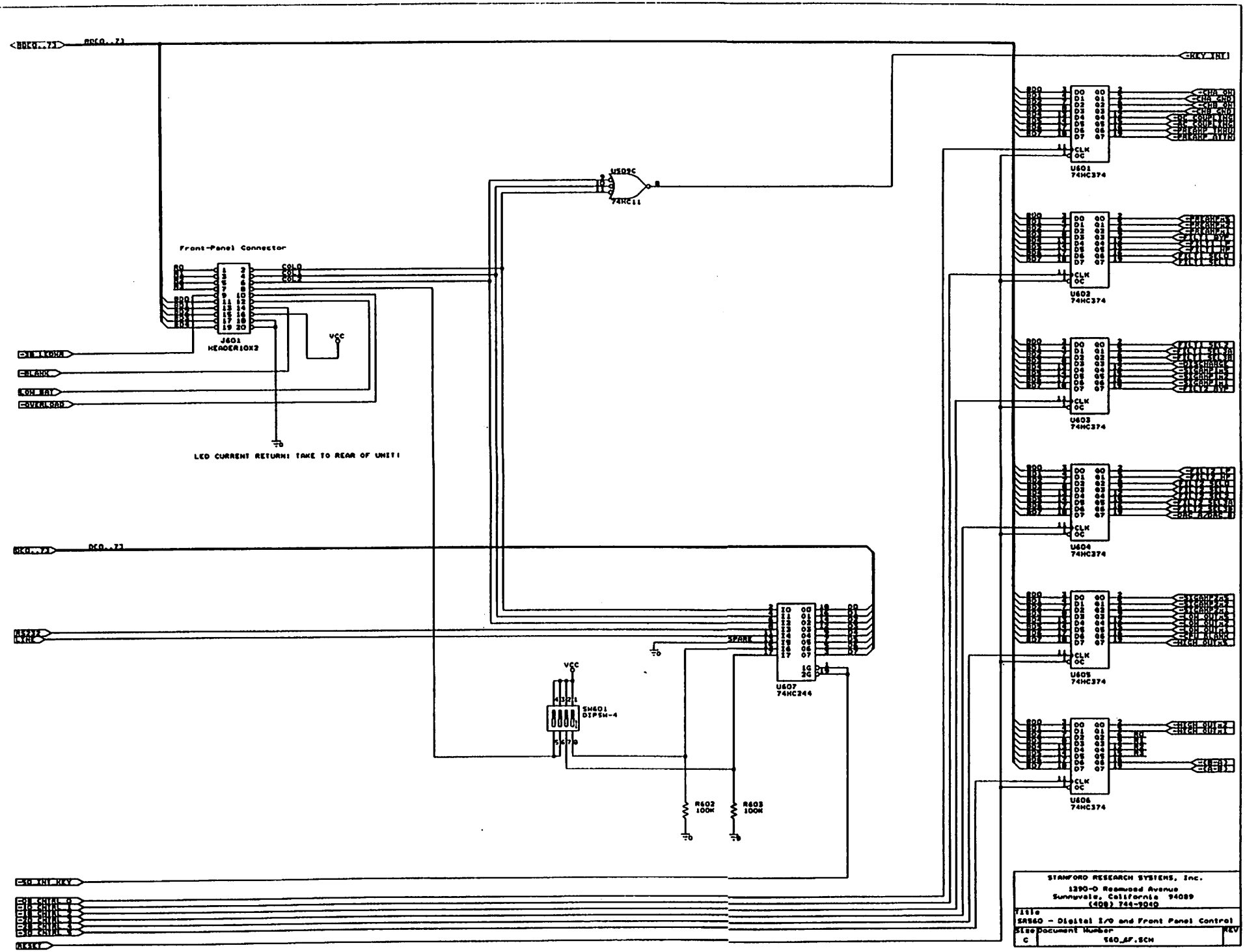

Input A
Input B
J101 BNC-INSULATED
J102 BNC-INSULATED
K103 DS2-ML2-OCSV
K104 DS2-ML2-OCSV
K101 DS2-ML2-OCSV
K105 DS2-ML2-OCSV
K102 DS2-ML2-OCSV
AC/DC Coupling
Invert Function
Front-End Offset Adjust
Front End Gain x1 OR x10
CHRR Adjust
LOW GAIN CHRR ADJ.
(LOW GAIN OFFSET)
(8 PIN DIP!)
NPD5564
Q103 Q102 2N3906
Q104 Q105 2N3906
Q106 Q107 2N3906
Q110 Q111 2N3906
Q108 Q109 2N3906
U102 OP37
U103 LF411
U105 LT1028
U104 74HC4053
U101A U101B U101C DG444
D101 1N753A
6.2V
R101 100M
R102 100M
R103 10
R104 10
R105 10
R106 10
R107 10
R108 249
R109 150
R110 100-1%
R111 1.000K
R112 10
R113 110.0
R114 110.0
R115 909.0
R116 499
R117 499.0
R118 1.000K
R119 165
R120 100K-1%
R121 75.0K
R122 1K
R123 909
R124 100-1%
R125 49.9K
R126 10M
R127 100K-1%
R128 909.0
R129 100K-1%
R130 100
R131 499.0
R132 10
R133 10
R134 75K
R135 10
R136 100K
R137 10
C101 10U-T35
C102 10U-T35
C103 10U-T35
C104 10U-T35
C107 .1U-PC
C108 33P
C109 33P
C110 6.8P
C111 68P
C112 .1U
C113 2.2U-T35
C114 2.2U-T35
C115 2.2U-T35
C116 150P
P101 100-20T
P102 20-20T
P103 100K-10T
P104 100K-10T
RX2 49.9-2W
(AT OUTPUT BNCs)
+10V
-10V
+6V_2
-6V_2
VCC
VCC2
FRONT_OUT
BLANK
STANFORD RESEARCH SYSTEMS, Inc.
1290-D Reamwood Avenue
Sunnyvale, California 94089
(408) 744-9040
Size C
Document Number 960_IF.SCH
REV

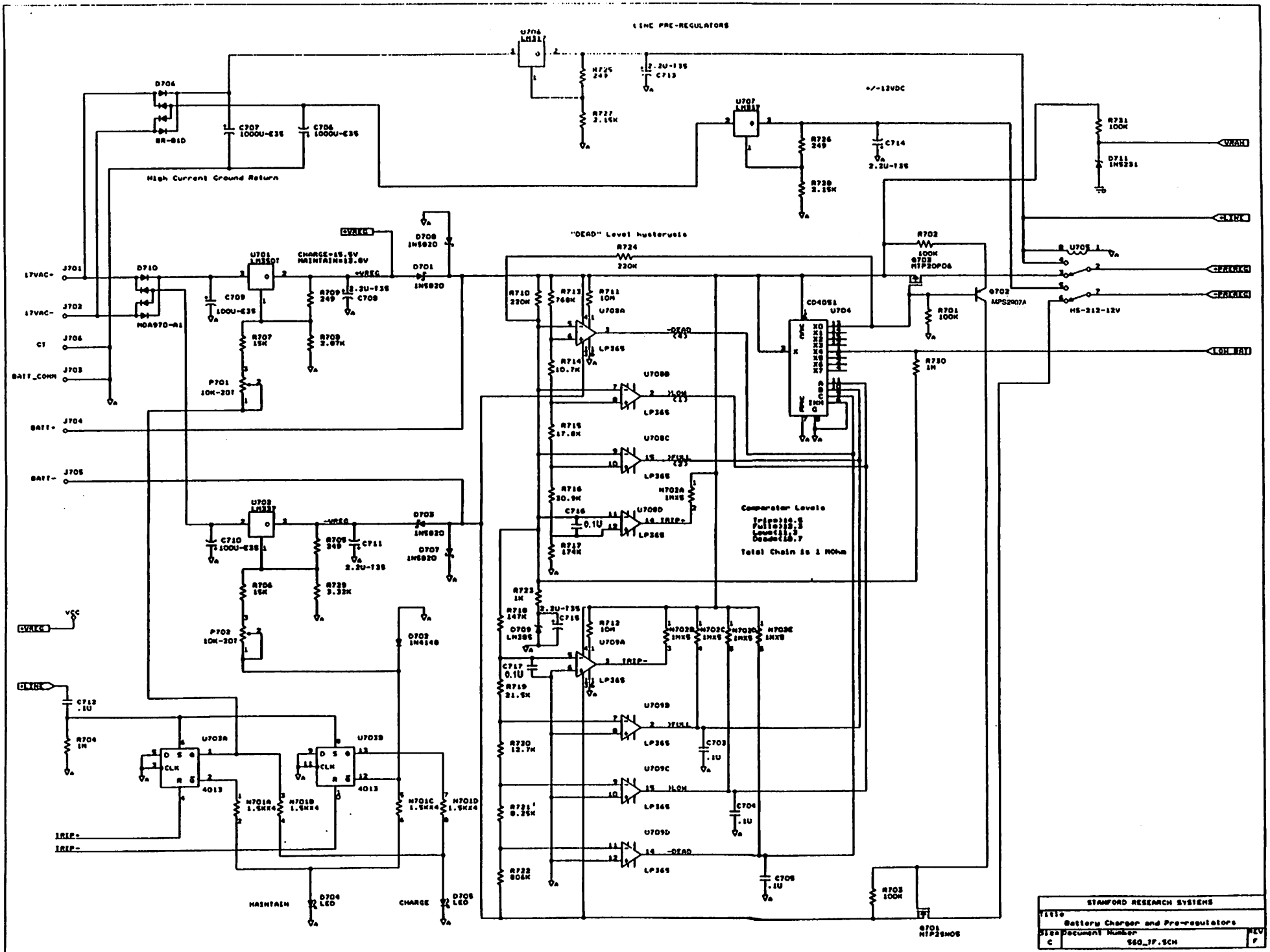

FILTER_OUT
U205D DG444
K201 DS2-ML2-DC5V
FRONT_OUT
VCC
Q201 2N3906
Q202
.03
.1
.3
1
3
10
30
100
300
1000
3000
10 k
30 k
100 k
300 k
1 M
f -3dB
R208 22.6K
C225 470U-E16
C224 470U-E16
R201 14.3K
C223 220U-E16
C222 220U-E16
R202 22.6K
C221 47U-E16
C220 47U-E16
R203 14.3K
C226 22U-E50
C227 22U-E50
R204 22.6K
C219 4.7U-E50
C218 4.7U-E50
R205 14.3K
C217 2.2U-E50
C216 2.2U-E50
R206 22.6K
C215 0.47U-E50
C214 0.47U-E50
R207 15.8K
C213 .1U
R209 15.8K
C212 .033U
R210 15.8K
C211 .01U
R211 15.8K
C210 .0033U
R212 15.8K
C209 .001U
R213 15.8K
C208 270P
R223 15.8K
C228 22P
R224 6.65K
C207 0P
R225 3.00K
C229 0P
+10V
R226 3.9K
+6V_2
C202 0.1U
D202 1N753A
C203 0.1U
D201 1N753A
-6V_2
R227 3.9K
-10V
U202 74HC4051
U203 74HC4051
R228 100
U101D DG444
DISCHARGE
R219 10
C204 2.2U-T35
C205 2.2U-T35
U204 LF356
R214 10
R220 604
R221 200-1%
R222 200-1%
U205A
U205B
U205C
U205E DG444
VCC2
R218 10
C206 2.2U-T35
C230 2.2U-T35
R216 10
R229 4.3K
C231 68P
R217 845
R215 200-1%
U201 OP37
NOTES: Electrolytic filter capacitors are Panasonic SU series
STANFORD RESEARCH SYSTEMS, Inc.
1290-D Reamwood Avenue
Sunnyvale, California 94089
(408) 744-9040
Size Document Number REV
C 960_2F.SCH F

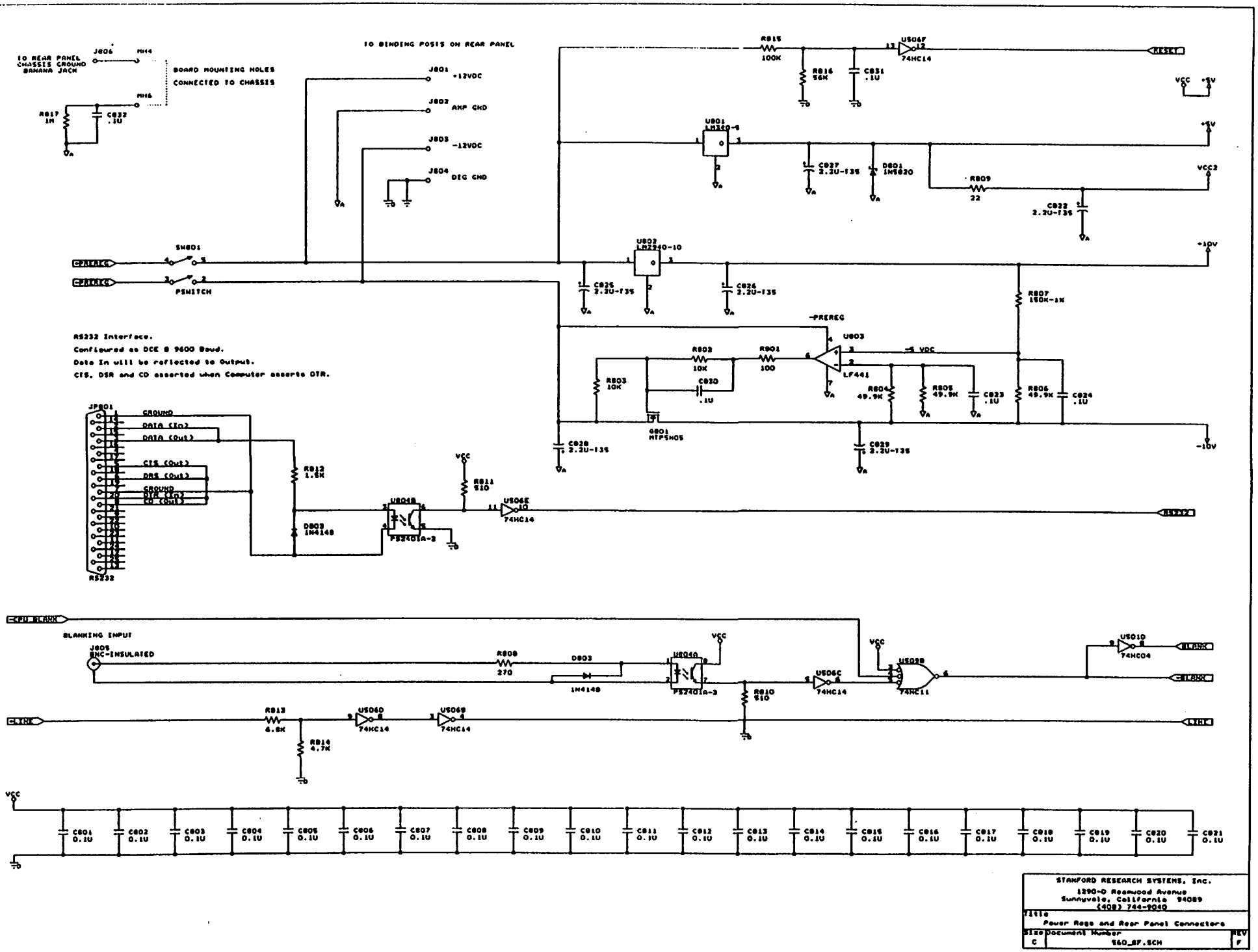

FILT2 BYP
U401A DG444
K301 DS2-ML2-DC5V
FILT2 OUT
FILT2 IN
VCC
Q301 2N3906
Q302
.03
.1
.3
1
3
10
30
100
300
1000
3000
10 k
30 k
100 k
300 k
1 M
R308 22.6K
C324 470U-E16
C323 470U-E16
R301 14.3K
C322 220U-E16
C321 220U-E16
R302 22.6K
C320 47U-E16
C319 47U-E16
R303 14.3K
C327 22U-E50
C328 22U-E50
R304 22.6K
C318 4.7U-E50
C317 4.7U-E50
R305 14.3K
C316 2.2U-E50
C315 2.2U-E50
R306 22.6K
C314 0.47U-E50
C313 0.47U-E50
R307 15.8K
C312 .1U
R309 15.8K
C311 .033U
R310 15.8K
C310 .01U
R311 15.8K
C309 .0033U
R321 15.8K
C308 .001U
R322 15.8K
C307 270P
R323 15.8K
C306 33P
R324 6.65K
C329 OP
R325 2.00K
C305 OP
-3dB
+10V
R326 3.9K
+6V_3
C325 0.1U
D301 1N753A
C326 0.1U
D302 1N753A
-6V_3
R327 3.9K
-10V
U301 74HC4051
U302 74HC4051
R329 100
U304D DG444
DISCHARGE
NOTES: Electrolytic filter capacitors are Panasonic SU series
R317 10
C302 2.2U-T35
U303 LF356
C303 2.2U-T35
R312 10
R318 604
R319 200-1K
R320 200-1K
U304A
U304B
U304C
U304E DG444
VCC2
R313 200-1K
R316 10
C304 2.2U-T35
U305 OP37
C330 2.2U-T35
R314 10
R330 3.3K
C301 6.8P
R315 64K
R328 10
FILT2 OUT
STANFORD RESEARCH SYSTEMS, Inc.
1290-D Reamwood Avenue
Sunnyvale, California 94089
(408) 744-9040
Title
SR560 - Configurable Filter and Gain (2)
Size C
Document Number
560_3F.SCH
REV F

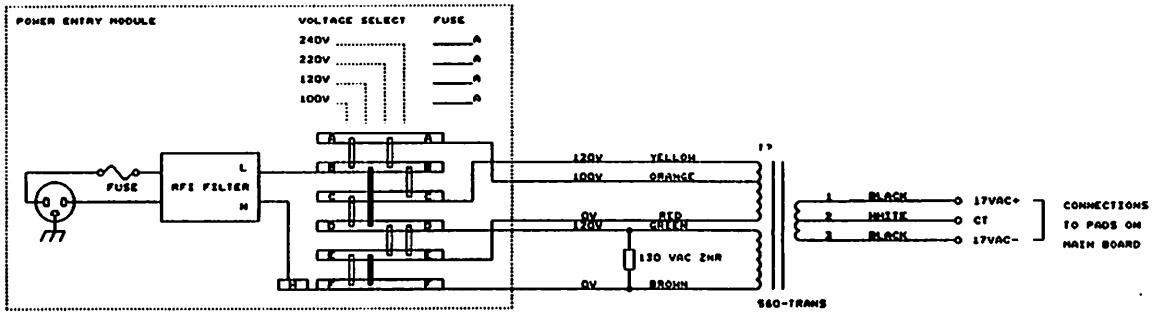

Offset Cancellation
Front Panel Offset Adjust
OUT
(50 OHM)
OUT
(600 OHM)
-OVERLOAD
STANFORD RESEARCH SYSTEMS, Inc.
1290-D Reamwood Avenue
Sunnyvale, California 94089
(408) 744-9040
Size C
Document Number
560_4F.SCH
REV F

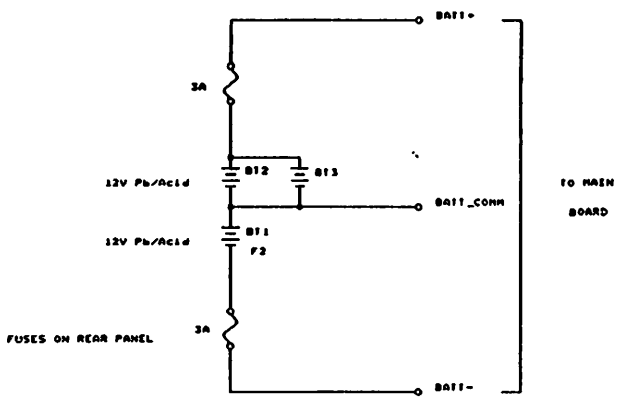

VCC VDD
VSS VEE
VRAM
RESET
-50_RS232CLR
-KEY_INT
DS01 1N4148
DS03 1N4148
RS03 1.5K
Battery Backup / RAM Power Circuitry
RS02 1.5K
QS01 2N3904
DS02 1N4148
US01A 74HC04
US08B 74HC74
US08A 74HC74
US09A 74HC11
Oscillator Shutdown Circuitry
Stop Clock on Port Strobe
Start clock on RESET, RS-232, or Key
DS05 1N4148
US06A 74HC14
C502 9-60P
C503 22P-NPO
RS01 5.1K
Set to 4.0 MHz (for 9600 baud)
US03 TMPZ84C00AP
RESET
INT
NMI
HALT
BUSRQ
CLK
A0..A15
D0..D7
RFSH
M1
IORQ
US01C 74HC04
US02A 74HC32
US02B 74HC32
US01B 74HC04
US02C 74HC32
US01F 74HC04
J501
CLOCK TEST POINT
US04
27C128
16Kx8 CMOS EPROM
US05
MK8116LP
2Kx8 CMOS RAM
US07 74HC154N
-40_STOP
US10 74HC373
US02D 74HC32
US01E 74HC04
BDF0..7
STANFORD RESEARCH SYSTEMS, Inc.
1290-D Reamwood Avenue
Sunnyvale, California 94089
(408) 744-9040
Title
SR540 - Microprocessor Section
Size C
Document Number
540_SP.SCH
REV F


Front-Panel Connector
J601
HEADER10X2
LED CURRENT RETURN! TAKE TO REAR OF UNIT!
U607
74HC244
SW601
DIPSW-4
R602
100K
R603
100K
U601
74HC374
U602
74HC374
U603
74HC374
U604
74HC374
U605
74HC374
U606
74HC374
STANFORD RESEARCH SYSTEMS, Inc.
1290-D Reamwood Avenue
Sunnyvale, California 94089
(408) 744-9040
SR560 - Digital I/O and Front Panel Control
Document Number
560_SF.SCH


LINE PRE-REGULATORS
+/-12VDC
High Current Ground Return
"DEAD" Level hysteresis
Comparator Levels
Trip+:14.6
Full:13.5
Low:11.3
Dead:10.7
Total Chain is 1 MOhm
MAINTAIN
CHARGE
-VREG
+VREG
+VREG
VCC
IRIP+
IRIP-
-DEAD
-FULL
-LOW
-PRERK
-PRERK
-LINE
VRAM
LOW_BAT
17VAC+
17VAC-
CT
BATT_COMM
BATT+
BATT-
HS-212-12V
STANFORD RESEARCH SYSTEMS
Title
Battery Charger and Pre-regulators
Size
C
Document Number
960_7F.SCH
REV
F

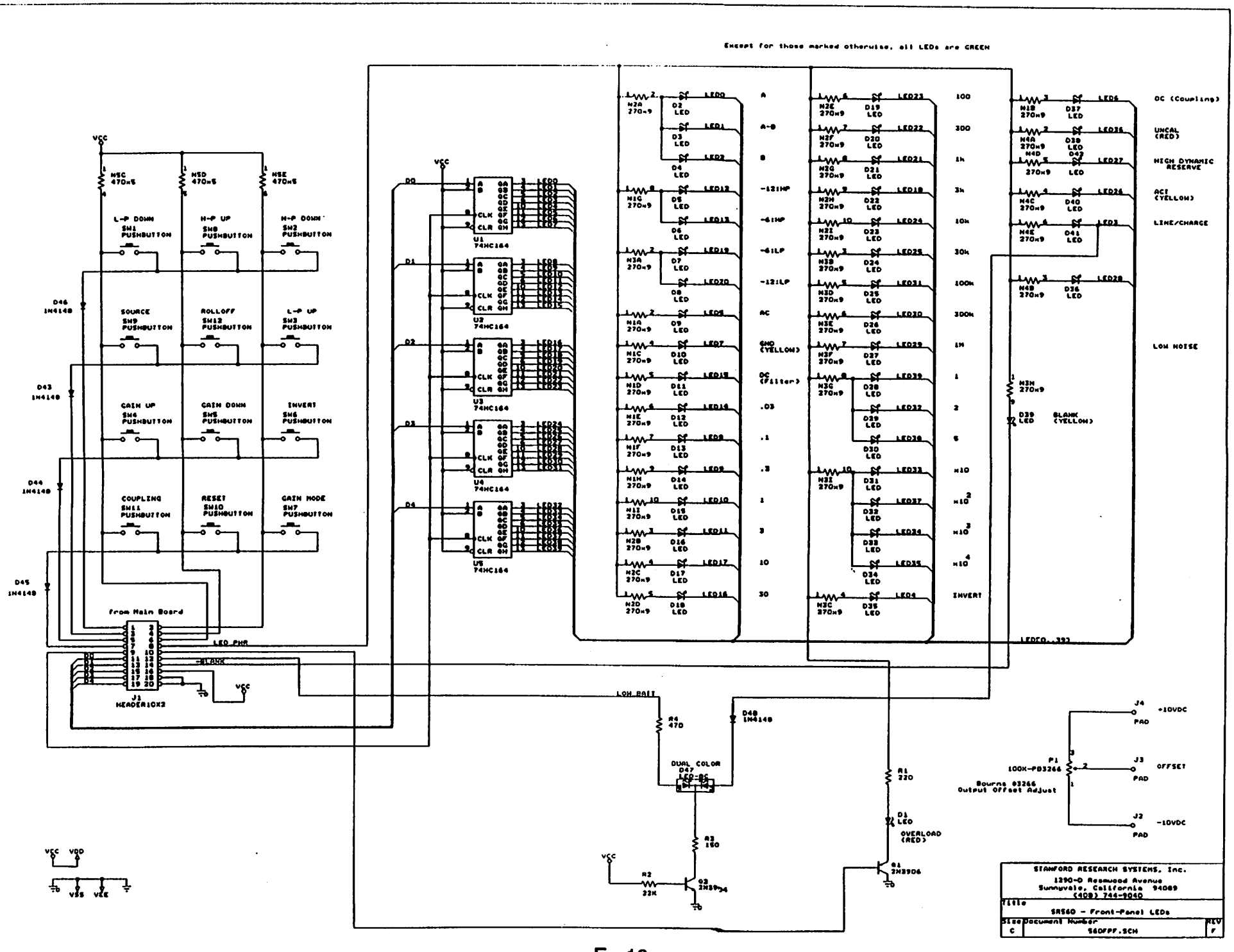

TO REAR PANEL CHASSIS GROUND BANANA JACK
J806
MH4
MH6
BOARD MOUNTING HOLES CONNECTED TO CHASSIS
R817 1M
C832 .1U
TO BINDING POSTS ON REAR PANEL
J801 +12VDC
J802 AMP GND
J803 -12VDC
J804 DIG GND
SW801
PSWITCH
+PREREG
-PREREG
R815 100K
R816 56K
C831 .1U
U506F 74HC14
RESET
VCC +5V
U801 LM340-5
C827 2.2U-T35
D801 1N5820
R809 22
C822 2.2U-T35
VCC2
U802 LM2940-10
C825 2.2U-T35
C826 2.2U-T35
+10V
R807 150K-1%
-PREREG
U803
R802 10K
R801 100
R803 10K
C830 .1U
-5 VDC
LF441
R804 49.9K
R805 49.9K
C823 .1U
R806 49.9K
C824 .1U
Q801 MTP5N05
C828 2.2U-T35
C829 2.2U-T35
-10V
RS232 Interface.
Configured as DCE @ 9600 Baud.
Data In will be reflected to Output.
CTS, DSR and CD asserted when Computer asserts DTR.
JP801
GROUND
DATA (In)
DATA (Out)
CTS (Out)
DRS (Out)
GROUND
DTR (In)
CD (Out)
RS232
R812 1.5K
D802 1N4148
U804B
PS2401A-3
VCC
R811 510
U506E 74HC14
RS232
-CPU BLANK
BLANKING INPUT
J805 BNC-INSULATED
R808 270
D803 1N4148
U804A
PS2401A-3
VCC
R810 510
U506C 74HC14
VCC
U506B 74HC11
U501D 74HC04
BLANK
-BLANK
-LINK
R813 6.8K
R814 6.7K
U506D 74HC14
U506B 74HC14
LINK
VCC
C801 0.1U
C802 0.1U
C803 0.1U
C804 0.1U
C805 0.1U
C806 0.1U
C807 0.1U
C808 0.1U
C809 0.1U
C810 0.1U
C811 0.1U
C812 0.1U
C813 0.1U
C814 0.1U
C815 0.1U
C816 0.1U
C817 0.1U
C818 0.1U
C819 0.1U
C820 0.1U
C821 0.1U
STANFORD RESEARCH SYSTEMS, Inc.
1290-D Reamwood Avenue
Sunnyvale, California 94089
(408) 744-9040
Title
Power Regs and Rear Panel Connectors
Size C
Document Number 960_BF.SCH
REV F





NOTE: FUSES REMOVED FOR EXTERNAL POWER VIA BINDING POSTS

STANFORD RESEARCH SYSTEMS, Inc. 1290-D Reamwood Avenue Sunnyvale, California 94089 (408) 744-9040		
Title: SR560 BACK PANEL		
Size: C	Document Number: S60RPF.SCH	REV: F


Except for those marked otherwise, all LEDs are GREEN
VCC
R5C 470ohm
R5D 470ohm
R5E 470ohm
L-P DOWN SW1 PUSHBUTTON
H-P UP SW8 PUSHBUTTON
H-P DOWN SW2 PUSHBUTTON
SOURCE SW9 PUSHBUTTON
ROLLOFF SW12 PUSHBUTTON
L-P UP SW3 PUSHBUTTON
GAIN UP SW4 PUSHBUTTON
GAIN DOWN SW5 PUSHBUTTON
INVERT SW6 PUSHBUTTON
COUPLING SW11 PUSHBUTTON
RESET SW10 PUSHBUTTON
GAIN MODE SW7 PUSHBUTTON
D46 1N4148
D43 1N4148
D44 1N4148
D45 1N4148
From Main Board
LED PWR
-BLANK
J1 HEADER10X2
U1 74HC164
U2 74HC164
U3 74HC164
U4 74HC164
U5 74HC164
LED0 A
LED1 A-B
LED2 B
LED12 -12:HP
LED13 -6:HP
LED19 -6:LP
LED20 -12:LP
LED5 AC
LED7 GND (YELLOW)
LED15 DC (Filter)
LED14 .03
LED9 .1
LED8 .3
LED10 1
LED11 3
LED17 10
LED16 30
LED23 100
LED22 300
LED21 1k
LED18 3k
LED24 10k
LED25 30k
LED31 100k
LED30 300k
LED29 1M
LED39 1
LED32 2
LED38 5
LED33 M10
LED37 M10 2
LED34 M10 3
LED35 M10 4
LED4 INVERT
LED6 DC (Coupling)
LED36 UNCAL (RED)
LED27 HIGH DYNAMIC RESERVE
LED26 ACI (YELLOW)
LED3 LINE/CHARGE
LED28
LOW NOISE
LED0..39
D39 LED BLANK (YELLOW)
LOW BATT
R4 470
D48 1N4148
DUAL COLOR D47 LED-BC
R1 220
D1 LED OVERLOAD (RED)
R3 150
R2 22K
Q2 2N3904
Q1 2N3906
VCC VDD VSS VEE
J4 +10VDC PAD
J3 OFFSET PAD
J2 -10VDC PAD
P1 100K-PB3266
Bourns 63266 Output Offset Adjust
STANFORD RESEARCH SYSTEMS, Inc.
1290-D Reamwood Avenue
Sunnyvale, California 94089
(408) 744-9040
Title
SR560 - Front-Panel LEDs
Size C
Document Number 560FFP.SCH
REV F